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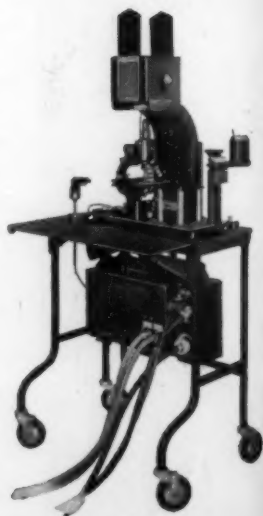
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Leaving this problem for a moment, we might ask: "What is the 'blind spot test' doing anyway, in a book like *Villee's Biology*?" The answer: It's there because of the author's conviction that *the human approach* is the most interesting and the most successful approach to the study of biology.

Dr. Villee believes that rods, cones, and foveas assume new importance in the eyes of the student when they can be used to explain "blind spots" and bad calls by umpires. In this book, therefore, the human organism is used as the principal example in each case, and the lower forms are brought in subsequently to point up evolutionary and comparative aspects.

Dr. Villee seems not to be alone in his enthusiasm for the human approach. A remarkable number of teachers are using his text right now, and this number is steadily increasing.

Biology: The Human Approach. By CLAUDE A. VILLEE, Harvard University. 580 pages, 6" x 9", with 250 illustrations. \$5.00.

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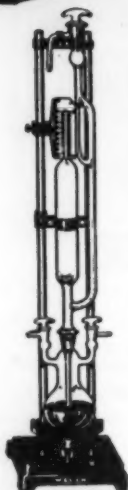
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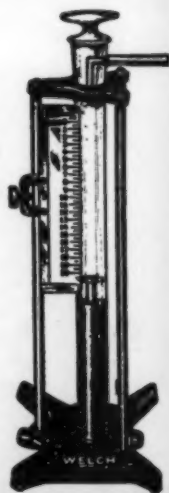
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Infrared Spectroscopy

SPECTROSCOPY in the infrared has come of age since the recent war period which witnessed the development of such detecting devices as the lead sulfide cell, the lead selenide cell, and the lead telluride cell. These detectors are photoconducting in character and have demonstrated a sensitivity increase of at least two orders of magnitude in certain regions of the spectrum over the traditional types, such as the vacuum thermocouple and the bolometer. Only for wavelengths greater than about $6\ \mu$ are the thermocouple and the bolometer superior to the photoconducting devices. The thermocouple and the bolometer are further being challenged by the pneumatic detectors, of which the Golay cell is the best-known example. These are in principle gas thermometers, rivaling in sensitivity the best vacuum thermopiles but having a much higher speed. Although no monumental advance in detecting sensitivity has been achieved for the spectral region beyond $6\ \mu$, it is not unreasonable to look for improvements in one form or another here, also, in the near future. Considering further the improvements that are currently being made in the sources of infrared radiation, it does not appear over-optimistic to envisage a tenfold increase in resolving power throughout most of the infrared region from 1 to $30\ \mu$.

It is an interesting observation that, in many of the spectrometers in use when the improved detectors were installed, no significant improvement in performance was observed. This may be interpreted to mean that infrared spectrometers had been constructed to be optically as good as, but no better than, their detectors merited. Experience is teaching

that many of the infrared spectrometers already in operation should be redesigned and equipped with optical components of higher quality, in particular with much improved dispersing components—i.e., better prisms and gratings. Experience is also teaching that, when this is done, the quality of the infrared spectra produced is very considerably improved. The best infrared spectrographs now in operation are recording spectra definitely comparable, and in some instances superior, to spectra recorded in other portions of the spectrum.

The great improvements in the techniques of infrared spectroscopy have given new impetus to the investigation of atomic spectra in this region. It is, moreover, now possible to study many more of the intimate details of molecular spectra than was previously feasible. The energies of a molecule in its normal electronic state are essentially energies of vibration and rotation. These motions are independent of each other to a first approximation, but it is well known that in higher orders of approximation they interact and give rise to interesting anomalies in the band structure. Some of these phenomena have been observed and studied carefully by the microwave spectroscopists, but the limited frequency range at their disposal makes it desirable to be able to study these effects in other regions of the spectrum. With spectrographs available now that are capable of resolving spectral lines separated by as little as one tenth of a wave number ($0.1\ \text{cm}^{-1}$), it appears we are about to "see face to face" what heretofore we have seen only "as through a glass darkly."

HARALD H. NIELSEN

*Department of Physics and Astronomy
The Ohio State University*

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Arthur E. Anderson, Professor of Electrical Engineering at the University of Connecticut, was one of the 21 college professors who spent the summer months last year working with the men who design and build electrical equipment for the Westinghouse Electric Corporation. The program is designed to provide college instructors with practical experience in industry. Here, as part of a research project, Mr. Anderson is using a small magnet to change the position of a metal disc enclosed in a glass tube.

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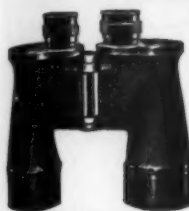
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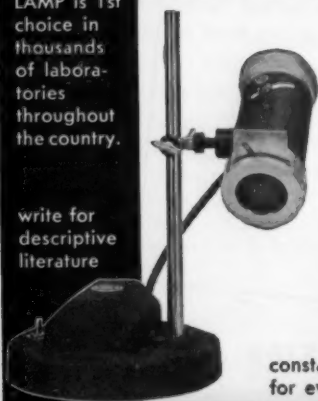
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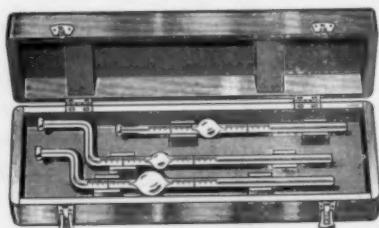
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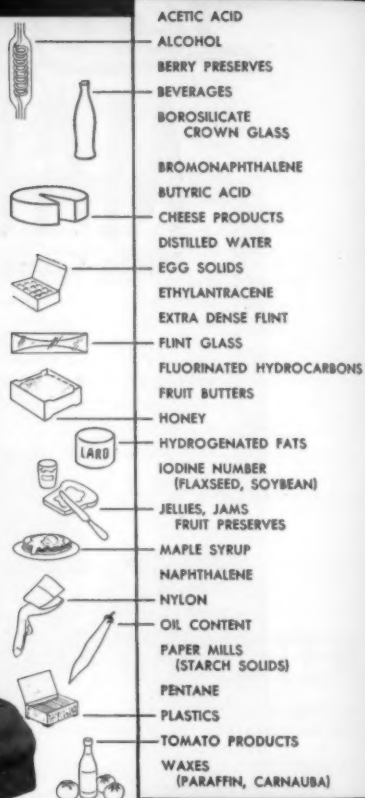
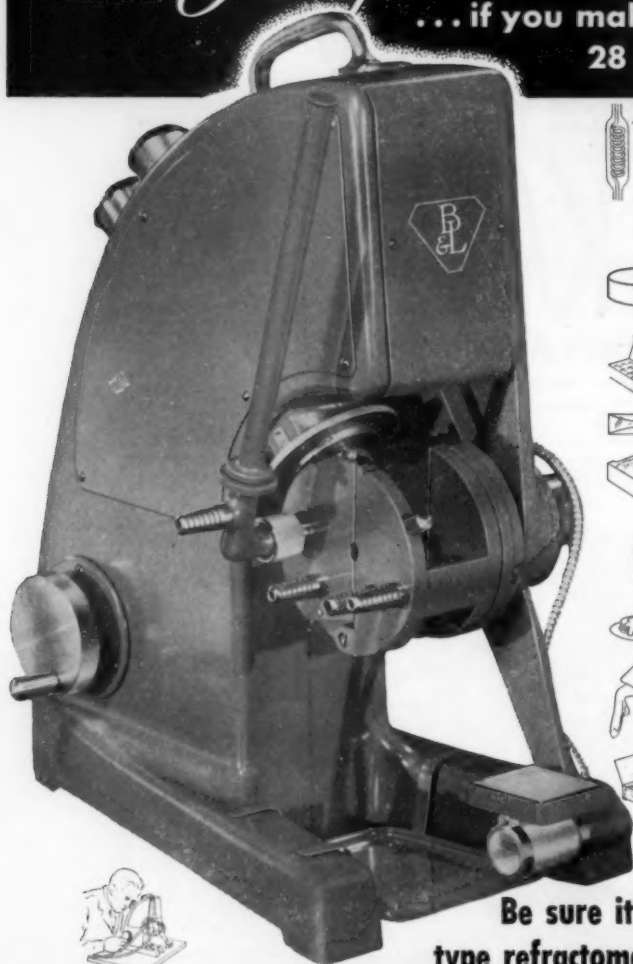
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The Scientist's Attitude Toward Government Employment¹

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SHORTLY AFTER THE END OF WORLD WAR II, it became abundantly clear to most interested persons that the government would continue to be the largest single employer of scientists and engineers in the country. It was also becoming apparent at that time that an increasing problem would confront the government in recruiting and in retaining its share of the limited supply of first-rate scientists and engineers.

In part, this problem was created by the reentry of industrial research organizations, universities, and private research foundations into the employment market as strong competitors of government for scientific and technical employees. In part, also, this problem was rooted in the prevailing demobilization psychology. Many technical men wanted to turn their attention to investigations of a nonmilitary nature. Others, who had interrupted their formal education during the war, or who had given up teaching positions, wished to return to the universities. The government itself, in the abruptness of the transition to a peacetime economy, in many instances made the technical man feel that his position was insecure, or that the continuance of his particular technical work was uncertain.

Other factors, related to the unsatisfactory nature of the experience of technical people in the government, began to receive attention. The President's Scientific Research Board noted, as the result of a survey conducted among scientists and engineers throughout the country, early in 1947, that:²

The generalization is widely accepted that the best research scientists are not to be found in the Government, and that it is difficult to recruit such men under the conditions prevailing in the Government service. The civil service system is criticized. It is alleged that scientific ability as such is not adequately recognized or rewarded. It is said that rewards rest on non-scientific considerations.

There is widespread belief that many fine scientific minds are "trapped in a blind alley" under present con-

ditions of Government employment and advancement. It is charged that technical administrators are often promoted solely because of long service, and that this contributes to placing a premium on mediocrity. A great deal of misinformation contributes to these attitudes, but, nevertheless, they have some influence upon young scientists choosing among a variety of career opportunities.

In 1948 the Office of Naval Research, taking cognizance of the problems of recruiting able scientists and engineers, as well as of the seemingly high rate of turnover among such personnel in government laboratories, sponsored an inquiry into the attitudes of a large group who had voluntarily resigned from government laboratories. It was hoped to elicit information that would be of value to the Navy and to the government generally, both in the recruitment and retention of competent technical personnel. An additional purpose was to learn precise attitudes toward technical employment in government, so that methods for appraising morale might be devised. It was also hoped that such materials would indicate whether reactions to technical employment in Navy laboratories differed significantly from the reactions of former employees of nonmilitary government laboratories.

An eight-page questionnaire composed primarily of open-end questions dealing with both the technical and the nontechnical aspects of the individual's government employment experience was sent to a group of 673 professional scientists and engineers who had voluntarily left their government positions during the year 1948.³ These individuals represented all the professional research men for whom addresses were available and who had resigned from seven of the largest Navy laboratories, seven of the largest nonmilitary government laboratories, and two of the larger Army laboratories. The laboratories were selected because of their size and on the basis of similarities in the types of technical persons employed, as well as for their geographic location in the field and in the Washington, D. C., area.

Of the recipients of the questionnaire 335, or 49.8 per cent, of the potential respondents made sufficiently complete and timely replies to permit their use. Considerable evidence suggests that a high degree of homogeneity existed in a number of important respects between the group that did not respond and the group

³ The year 1948 was selected to avoid, insofar as possible, including within the study those who had entered government service during the war with no intention of remaining after the war was over.

¹ A two-volume report on *Attitudes of Scientists and Engineers about their Government Employment* was prepared by the authors and released by the Maxwell Graduate School of Citizenship and Public Affairs, of Syracuse University. This research was supported by the Manpower Branch, Human Resources Division, Office of Naval Research. The material set forth in this article is based on the full report. The views expressed are the exclusive responsibility of the authors and do not represent the policies or opinions of the Navy Department.

² John R. Steelman, *Administration for Research*, Vol. III, of *Science and Public Policy*. Washington, D. C.: GPO, 143 (1947).

that did, although it cannot be said conclusively that the response data are representative of the views of all 673 individuals.⁴

The respondents to the questionnaire were in the main engineers, physicists, chemists, and mathematicians. Most of them had occupied positions at grade P-5 or lower, and nearly three fourths of them were below thirty-five years of age. Practically all were college graduates, and over a third had M.S. or Ph.D. degrees. Somewhat fewer than half the respondents had had prior experience working in government laboratories before taking the positions from which they resigned in 1948. Almost a quarter of them had had prior experience working for industrial research organizations, and about an equal proportion had done professional work in university laboratories at some previous time.

Upon resigning from their government positions in 1948, 6 per cent left employment entirely; about 24 per cent returned to universities for the purpose of continuing their education; 34 per cent secured employment in private industry; and 36 per cent transferred to other government positions. If these percentages are indicative of the general situation, they suggest particularly that a third or more of the group, usually presumed to have been lost to public service, are in fact still working for the government, but in other positions.

AREAS OF SATISFACTION AND DISSATISFACTION

In reply to the several questions that dealt with attitudes about their last government positions, the respondents expressed a variety of satisfactions and dissatisfactions which were found to be constantly recurrent. The repetitiveness of these elements is indicative of their major importance in the minds of the respondent scientists and engineers. The nine most frequently mentioned are discussed below in diminishing order of frequency of mention.

The nature of the questionnaire was such as purposely to bring to the fore a considerable amount of adverse criticism about government employment experience, and the remarks that follow tend to emphasize much of this. Accordingly, it is important to bear in mind that, in an evaluation of their government employment experience, 80 per cent of the respondents indicated they felt that experience had ranged from satisfactory to excellent. This suggested that for the group as a whole there was a decidedly favorable reaction to having worked in government laboratories.

Compensation and opportunities for economic advancement. The majority of respondents were dissatisfied with the compensation and the opportunities for economic advancement in their government positions. This type of dissatisfaction was most frequently cited

as the principal reason for resigning. The sources of dissatisfaction were more often associated with the administration of pay schedules and the handling of promotions than with the adequacy of government pay scales. Where criticisms of the pay scales did occur, they involved the adequacy of these scales for top-level positions. One aspect of the compensation picture that received consistently favorable comment was that of the government's sick- and annual-leave policies.

A significantly larger number of individuals who had left positions in nonmilitary laboratories expressed dissatisfaction with the economic aspects of their government employment experience than did persons who left Navy laboratory jobs.⁵

Opportunities to do interesting, challenging, and important work and to have freedom in carrying on research. Most respondents were satisfied with this phase of their government employment. The criteria most often used in making an assessment of their opportunities to do interesting, challenging, and important work and to have freedom in their technical pursuits provide some insight into the nature of these concepts. The criteria may be summarized as follows:

- a) The work made use of the respondent's training and job experience.
- b) The work was within the field of the individual's principal interest.
- c) The work was diversified and called for the use of a variety of skills and knowledge.
- d) The work was considered to be important to the individual. The varied bases for assessing importance were:
 1. Technical importance, meaning to the individual himself or to high-level technical personnel, or related to fundamental research or to new developmental problems.
 2. Organizational utility and need.
 3. Social usefulness.
- e) There was a reasonable degree of individual freedom of research. This was shown most commonly to mean:
 1. A role in the selection of assignments.
 2. The right to initiate research proposals.
 3. Responsibility for laying out technical work plans.
 4. Responsibility to one's technical peers for the quality of one's technical work.

The administration of staff and service functions. Primarily included within the term "staff and service functions" were comments in respect to personnel policy and administration, supply and procurement, shop service, facilities, and space and equipment. The great majority of these comments, which, it may be added, occurred frequently, were unfavorable. For example, this was the most disliked aspect of the government positions which the respondents held in 1948. Poor administration of such activities was the reason most often cited as making government employment undesirable. As might be expected, because of their administrative responsibilities, respondents who had been in middle- and upper-grade positions were more critical of the handling of these matters.

The most consistently unfavorable comment was

⁴ A lack both of time and of accurate data on the number of persons directly employed in research and development work made it impossible to develop a sample that would be representative of all scientists and engineers who voluntarily resigned from government laboratories during 1948. The attitudes reported are, however, representative of a sufficiently large and varied group to be highly suggestive of attitudes more generally held.

⁵ Observed differences were tested for their significance, wherever the frequency of the data permitted, through use of the chi-square test at the 1 per cent level of significance.

directed at the slowness and inefficiency with which various personnel actions were accomplished in the laboratories. Individuals employed in the administration of personnel activities were criticized as being unimaginative, nonprofessional, and bureaucratic in their approach. Frequently mentioned were the failures to make any real effort to remove incompetent personnel and to discriminate between outstanding and highly productive technical employees and those described as of average ability.

Favorable comment about personnel policies and administration related to the absence of discrimination, particularly with regard to the employment of women, and to safeguards provided to avoid arbitrary dismissals.

Responses critical of supply and procurement activities generally referred to delays caused by the red tape involved in justifying selective procurement or to the restrictions placed on the authority of laboratory supply and procurement personnel. Employees engaged in administering supply and procurement activities were also criticized as lacking knowledge of scientific equipment and materials, or for being excessively concerned with standardizing equipment and sources of supply. They were also felt to be unwilling to make the effort necessary to meet scientific needs within the framework of rules and regulations covering federal supply and procurement activities.

The limited number of responses critical of the administration of technical service activities (such as are carried on in machine, instrument, carpentry, drafting shops, etc.) suggested that the majority were satisfied with the handling of these services. Facilities and equipment in government laboratories were nearly always spoken of in favorable terms.

The competence of supervisors and co-workers. A substantial majority of the respondents believed that the professional competence of their supervisors and co-workers was good, very good, or excellent. The attributes that were held to make a supervisor desirable were technical competence and actions that evidenced a concern with, and consideration for, subordinates. Qualities of friendliness, cooperativeness, and technical competence were also mentioned.

The minority who expressed dissatisfaction with supervisory personnel related this to technical and administrative incompetence, thoughtlessness, selfishness, arbitrariness, and a tendency to oversupervise. The dissatisfaction in respect to co-workers related to their technical incompetence, to their lack of adequate training, and to professional jealousies.

Conditions of professional atmosphere, morale, and working conditions. There was no clear-cut pattern of general satisfaction or dissatisfaction with these conditions. In assessing the circumstances that create positive feelings about the professional atmosphere, morale, and working conditions, the respondents emphasized the following:

a) A good scientific atmosphere, good working conditions, and high morale were frequently said to result from the presence of a staff of high quality.

b) The use of high standards in the review and approval of project proposals, and particularly in the appraisal of scientific work in lieu of commercial criteria, were said to contribute to good morale and a desirable atmosphere.

In describing the conditions that create negative feelings about the professional atmosphere, morale, and working conditions, these points were stressed:

a) A sense of apathy and inertia was felt to prevail in government. This was attributed to the lack of competitive motivation.

b) Congressional criticism of public employees, loyalty oaths, "witch hunts," and excessive security provisions were cited as disruptive of morale and the research atmosphere.

Opportunities for professional development and advancement. A large number of the responses suggested that professional advancement is viewed essentially as being the enhancement of one's prestige and status among one's professional colleagues. There was generally negative criticism of the opportunities to enhance one's reputation because of security restrictions on discussion and publication, as well as fund restrictions on travel, on attendance at professional meetings, and on technical publications. The mediocre nature of research programs, the poor reputation of the organization, and the absence of top-flight technical personnel were in some instances frequently cited as reasons for this opinion. Favorable responses were made, however, about formalized arrangements for on-the-job training and for joint training and work arrangements with colleges and universities.

Job security and retirement benefits. Most of the respondents expressed satisfaction with the job security aspects of their government employment. All the comments regarding the retirement system were of a favorable nature. Those who did not leave the public service more consistently expressed satisfaction with government provisions for job security and retirement. In a few instances, feelings of job insecurity were related to budget fluctuations, reorganizations, "temporary" classifications, and the tendency in some laboratories to replace staff members with other individuals possessing more extensive formal training.

Administration of the technical organization and program. A small majority of the respondents expressed the opinion that technical administration was less than satisfactory. These criticisms, which were voiced more frequently by those who had occupied high-level positions, covered all the processes of program planning and execution, including the participation in these activities of personnel at department, bureau, and laboratory levels. The bulk of the critical responses was directed to the departmental and bureau levels, and nearly all the favorable responses were related to the quality of technical administration at the laboratory level. This is interesting in view of the fact that the respondents' most immediate experience was in the laboratories, and presumably their most informed evaluation could be made about operations at this level.

TABLE 1

Conditions that make any technical position desirable	Advantages of employment		
	Government	University	Industrial
1. Opportunity to do interesting, challenging, or important work and to have more freedom in or responsibility for one's work	1. Job security	1. Freedom of research and opportunity to pursue research work of interest to the individual	1. Adequate compensation
2. Adequate compensation and economic advancement	2. Desirable leave policies	2. Desirable environment and professional atmosphere	2. Opportunity for advancement
3. Desirable working conditions with respect to equipment, plant facilities, and the handling of service functions	3. Opportunity to do interesting and important work, and to have freedom of action in research	3. Desirable working conditions	3. Good equipment and facilities
4. Opportunity to work with competent and congenial co-workers	4. Good physical facilities and equipment	4. Competent associates and co-workers	4. Desirable working conditions
5. Opportunity for professional development, advancement, and recognition	5. Compensation	5. Opportunity for professional development and advancement	5. Competent supervisors and co-workers
6. Opportunity to work for competent supervisors	Disadvantages of employment		
7. Matters of personal convenience and preference	Government	University	Industrial
8. Personal security	1. Poor general administration, including personnel administration	1. Inadequate compensation	1. Job insecurity
9. Opportunity for advancement based on merit	2. Poor compensation	2. Poor equipment and facilities	2. Production demands and pressures
10. Adequate number of competent assistants	3. Poor advancement opportunities	3. Excessive teaching load	3. Poor working conditions
	4. Lack of opportunity	4. Poor chance for advancement	4. Inadequate leave and vacations
	5. Lack of freedom of action and of challenging and interesting work	5. Poor working conditions	5. Lack of patent rights

A lack of stable, well-conceived, long-range plans was the most frequently mentioned criticism. The next largest group of responses made reference to inadequate coordination of the technical program or its poor direction. Finally, the technical leadership was held by many not to have measured up to its task of administering large-scale technical organizations and programs. The majority commented favorably on the competence of technical administration at laboratory levels.

Attitudes of professional colleagues and friends toward the work of the respondents' last government organization. Nearly three fourths of the respondents felt that their professional colleagues and friends held decidedly favorable views about the work of the government laboratories in which they were employed. This suggests that most of them did not feel that their prestige had suffered because of public employment, which might have contributed to their decision to leave government positions.

ADVANTAGES AND DISADVANTAGES OF EMPLOYMENT IN GOVERNMENT, UNIVERSITY, AND INDUSTRIAL RESEARCH

The respondents were asked to set forth the professional and personal conditions which, *in general*, they felt make for a desirable position in their field.

They were also requested to express opinions about the advantages and disadvantages of employment for persons of their profession in government, university, and industrial employment.

Table 1 lists in descending order of frequency of mention the ten categories of conditions which the respondents cited in answering the questions.⁶ Also listed are the five most frequently mentioned categories of advantages and disadvantages felt by the respondents to characterize government, university, and industrial technical positions. As may be seen from the table, no clear-cut pattern of preference was revealed regarding the desirability of any one employment area over another, when it is measured against the abstract standard of conditions which, in general, seem to make a technical position desirable.

The respondents were also asked to indicate which of the three employment areas, government, university, or industry, would, in their opinion, constitute the most desirable working situation for competent young and competent mature technical personnel. Forty-seven per cent selected private industry as being most

⁶ This ordering of categories was based on the responses to this specific question. The earlier ordering of categories was made on the basis of the total number of responses given to questions designed to elicit favorable, as well as unfavorable, comments with respect to various aspects of government employment.

desirable for young scientists and engineers, 26 per cent selected government, and 15 per cent universities. The distribution of responses in regard to the most desirable employment area for mature persons closely followed this breakdown.

In view of the fact that private industry was most frequently characterized as being advantageous in respect to compensation, it may be suggested that, in evaluating the comparative desirability of the various employment areas, the matter of compensation appears to have been considered most important by many respondents. This finding further suggests that, as between jobs offering advantages in respect to compensation as compared with advantages in respect to opportunities to do interesting and challenging work, more of the respondents would tend to favor the former than the latter.

GENERAL CONCLUSIONS

The findings did not support a conclusion that the majority of these scientists and engineers left their government positions because of deep-seated dissatisfactions with their employment experience. Indeed, the over-all reaction to that experience was favorable, although there were numerous matters about which dissatisfactions were expressed. This conclusion is further borne out by the fact that most of the respondents were at age and experience levels where there tends to be a high degree of employment mobility, and most of those who transferred to other government jobs or outside employment did so at a promotion.

Since 36 per cent of the respondent group, all of whom had voluntarily resigned, went to other government positions, it may be inferred that the government, viewed as a single employer, is actually losing fewer technical persons than is commonly supposed. Accurate judgments of the actual losses to the public service by voluntary resignations of technical personnel are precluded by inadequate statistical data. It may be suggested that the opportunities to transfer within the public service are advantageous to the scientist in giving him a means of broadening his experience and of finding the types of positions most suitable to his needs and interests. Likewise, the government's provisions for job security and retirement appear to be positive forces tending to influence individuals in their decision to remain in the service. On the other hand, there is an economic and a technical cost involved in intragovernment transfers that should not be ignored, as seems currently to be the case.

No marked distinction in the patterns of attitudes of respondents from Navy laboratories and of respondents from nonmilitary government laboratories was revealed. This seems to belie the view that employment in Navy laboratories is less desirable than employment in nonmilitary government laboratories. On the other hand, there was little indication that employment in Navy laboratories was considered preferable.

The criticisms of the administration of the technical program suggested essentially that a lack of adequate

program planning characterizes technical administration at the organizational levels above the laboratory. Scarcely any respondents suggested the prevalence of too much planning or of overly rigid and inflexible programming.

Furthermore, the loss of freedom in research endeavor was more often said to be the result of inadequate programming at higher echelons than of excessive programming. Freedom was defined as the opportunity to initiate ideas with a reasonable expectation of obtaining support, to participate in the selection of one's work assignments, and to assume responsibility for laying out one's technical work plans. Where bureau and department levels were believed to be poorly organized to permit such opportunities and responsibilities in the laboratories, or were felt to be actively frustrating them, the consequence was a feeling of lack of freedom.

Adverse criticisms of compensation, administration of pay scales, handling of promotions and other personnel policies and practices reflected a major source of dissatisfactions. This suggests the need for modification and improvement of personnel policies and practices, and the quality of the staffs handling such activities. There were also indications of need for a more complete understanding on the part of technical people themselves that a personnel system designed to achieve merit and equity necessarily involves the imposition of some restraints and controls. In addition, it appeared from the response data that scientists and engineers working in the government do not always recognize that certain of the administrative tasks they are required to perform are both legitimate and inevitable in large-scale organizations and under a democratic form of government.

Both the competence of technical administration and the efficiency with which staff and service functions are handled emerged as the elements of primary importance in the maintenance of high morale and desirable working conditions. This suggests that efforts designed to achieve improved organizational morale, which concentrate solely on staff and service problems, may, in many situations, fail to produce the desired objective.

The major attitudes revealed by the study indicate that these scientist and engineer respondents were not unique in their employment requirements and demands. They share with almost all types of workers a concern about pay, employment location, their chances of getting ahead, working conditions, and the congeniality and competence of associates and supervisors.

It is perhaps less apparent that those needs and interests which center around the scientist's concern with the conduct of his technical projects and program are also shared by nonscientific workers. The uniqueness of the problems of the research man is frequently pointed to, especially as it relates to his desire to be creative, his need for freedom of activity, and his wish to be free from nontechnical responsibilities. The concepts of freedom and creativity that emerged from the study

suggest that scientists and engineers do not differ in these respects from other workers. Indeed, industrial studies made in mass-production environments have indicated that the industrial worker, too, desires to share in program development, to make suggestions about his work and the work of his shop, and to have adequate responsibility and authority to do his job.⁷ Apparently the characteristics that are commonly supposed to distinguish scientific personnel from all other types of individuals are, in fact, simply variations of degree, rather than differences of kind.

One final observation should be made in respect to the differences in attitude patterns that apparently

⁷ Fritz Roethlisberger, *Management and Morale*, Cambridge, Mass.: Harvard Univ. Press (1941); Elton Mayo, *Social Problems of an Industrial Civilization*, Cambridge: Harvard Univ. Press (1945).

characterized the respondents from some laboratories as compared with those from others. These differences were not presented in the formal report for a number of reasons, one of which was that in several instances there were too few respondents to permit valid statistical comparisons to be made. Nonetheless, it was evident that the quality of morale among respondents from the several participating laboratories did differ, with some laboratories having seemingly engendered more favorable attitudes. This suggests that there is need for the development of attitude-measuring instruments that can be used on a repetitive basis to appraise morale in individual government laboratories. Such devices should materially assist in the location of trouble spots and would represent a necessary first step in the development of improved morale.

Technical Papers

Recovery from Radiation Injury¹

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The LD₅₀² for intact young adult mice³ has been shown to be in the neighborhood of 550 r, whereas the LD₅₀ for mice with lead-shielding of the exteriorized spleen during exposure to total-body x-radiation is about 1,025 r (1, 2). In contrast to the hematopoietic changes seen after the same exposure without spleen-shielding, no anemia, and only a transient leucopenia, appeared in spleen-shielded mice exposed to 1,025 r. This was attributed to the fact that ectopic blood formation was intensified in the shielded spleen within 48 hr after the exposure, and recovery of other hematopoietic tissue occurred within 8 days. In the animals without spleen-shielding, no recovery of hematopoietic tissue occurred before death. This brief report attempts to clarify some of the factors involved in this observation.

The techniques employed in these experiments are essentially similar to those reported previously (2). Tissues were encased in 1/4-in. thick lead shields. The x-radiation was generated in a 250-kvp machine operating at 15 ma. The target distance was 59 cm. All animals were anesthetized with Nembutal (0.072 mg/g) during irradiation.

As is shown in Table 1, lead-shielding of part of the exteriorized liver, the exteriorized intestine, the

¹ This investigation was supported (in part) by a research grant from the National Cancer Institute, U. S. Public Health Service, and by a grant from the Armour Laboratories.

² Dosage required to kill 50% of animals in 28 days.

³ CF-1. Raised by Carworth Farms—homozygous for recessive genes aa, bb, cc.

TABLE 1
SURVIVAL OF MICE EXPOSED TO 1,025 r X-RADIATION
WITH LEAD PROTECTION OF VARIOUS TISSUES

No. animals	Tissue lead-shielded	Survival (%)	Hematopoietic recovery (8 days)
135	Exteriorized spleen (0.1 g)	77.7	Complete (++++)
93	None	0	0
15	Exteriorized lobe of liver (0.8 g)	33	Nearly complete (+++)
15	None	0	0
15	Exteriorized intestine (2.5 g)	26.6	Nearly complete (+++)
15	None	0	0
18	Head (3.0 g)	27.7	Only partial (+)
12	None	0	0
15	Right hind limb, including thigh (1.5 g)	13	Not studied
28	Exteriorized right kidney (0.19 g)	0	0
8	None	0	0

entire head, or one hind leg, including the thigh, enhances survival of mice exposed to 1,025 r total-body x-radiation. Survival under these circumstances is considerably less than for spleen, shielding. Shielding one exteriorized kidney does not enhance survival. Recovery of the irradiated hematopoietic system and of the gastrointestinal tract, as judged by histopathologic study, is essentially complete within 8 days in spleen-

TABLE 2

SURVIVAL OF MICE EXPOSED TO 1,025 r WITH LEAD PROTECTION OF THE SURGICALLY MOBILIZED SPLEEN WITH REMOVAL OF THE SPLEEN AT VARYING INTERVALS AFTER X-RAY

No. mice used	Spleen-shield-ing	Interval of splenectomy after irradiation	Survival (%)
24	Yes	Within 10 min before x-ray	0
24	"	Within 5 min after x-ray	0
54	"	1-6 hr after x-ray	66
95	"	2 days after x-ray	39

shielded mice (2). Recovery of these tissues in liver- or intestine-shielded animals at 8 days is nearly as far advanced as in the spleen-shielded animals, whereas after lead-shielding of the head, recovery of the tissues is minimal at this interval and nil after kidney-shielding.

The survival of mice in which the circulation to the shielded spleen is clamped off during exposure of the animal to 1,025 r (the clamp is released immediately thereafter) is approximately the same as the survival of animals with spleen-shielding without clamping.

Surgical extirpation of the shielded spleen at intervals after exposure to 1,025 r shows that a beneficial effect on survival, on regeneration of hematopoietic tissue, and on regeneration of the gastrointestinal tract has already been exerted if the shielded spleen has been left intact in the circulation for 1-6 hr (Table 2).

Transplantation of 4 spleens (total weight ca. 10 mg) from mice 1-12 days old into the peritoneal cavity of mice immediately after exposure of the recipient adult mice to 1,025 r total-body x-radiation significantly increases the survival of the irradiated mice and hastens regeneration of hematopoietic and gastrointestinal tissue (Table 3). Similar transplantation

TABLE 3

SURVIVAL OF MICE EXPOSED TO 1,025 r X-RADIATION WITHOUT LEAD PROTECTION OF THE SURGICALLY MOBILIZED SPLEEN WITH AND WITHOUT IMPLANTATION OF SPLEENS FROM YOUNG MICE AFTER X-RAY

No. mice used	Spleen implants within ½ hr after irradiation	Survival (%)	Hematopoietic recovery (8 days)
112	None	0	None
63	4 spleens from 1-12-day-old mice	38	Complete
18	2 spleens from 4-5-wk-old mice	45	Not studied
24	4 spleens from 1-8-day-old mice implanted 2 days after irradiation of the recipient	20	" "

of 4 fresh spleens from mice 1-8 days old into adult mice 2 days after exposure to 1,025 r total-body x-radiation likewise enhances survival, but not so effectively as earlier transplantation.

These facts indicate that in contrast to the action of glutathione (3), cysteine (4), O₂ deprivation (5), or cyanide (6), which must be administered before or during irradiation in order to reduce the expected radiation mortality, the factor involved in the shielding or transplant experiments is unnecessary during the actual irradiation and is definitely effective after irradiation.

These experiments involving spleen- or liver-shielding or spleen transplants strongly suggest that the factor responsible for recovery from radiation under these conditions is a substance of a noncellular nature. It seems unlikely that (1) cells migrate out from the shielded or transplanted tissue and are responsible for the enhancement of recovery, or (2) that irradiation of tissue produces a "toxin" and that the shielded or implanted tissues exert a direct detoxifying action upon contact with the "toxin." Our present efforts are concentrated on attempts to study the efficacy of simple water extracts of spleen and embryonic tissue on survival and hematopoietic recovery of irradiated mice. The potential implications of these findings in the therapy of radiation injury and in certain other clinical states are obvious.

References

1. JACOBSON, L. O., et al. *J. Lab. Clin. Med.*, **34**, 740 (1949).
2. JACOBSON, L. O., et al. *Ibid.*, **35**, 746 (1950).
3. CHAPMAN, W. H., et al. *Naval Medical Research*, Sept. 1, 1949.
4. PATT, H. M., et al. *Science*, **110**, 213 (1949).
5. DOWDY, A. H., BENNETT, L. R., and CHASTAIN, S. M. *Univ. Calif. (Los Angeles) Publ. Rept. No. 55* (Jan. 31, 1950).
6. BACQ, A. H., et al. *Science*, **110**, 356 (1950).

Nitrogen Fixation by Sulfate-reducing Bacteria Indicated by Nitrogen/Argon Ratios¹

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In the course of investigations (1) on the utilization of molecular hydrogen by autotrophic, anaerobic, sulfate-reducing bacteria belonging to the genus *Desulfovibrio*, evidence was obtained for the fixation of free nitrogen. In preliminary experiments inverted vials in pairs were placed in glass-stoppered bottles filled with sea water, which served as a suitable mineral medium for the growth of H₂-utilizing sulfate reducers. One vial was filled with H₂ and the other with N₂ as an "inert" control.

It soon became evident, however, that N₂ was not inert in the presence of hydrogenase-producing species

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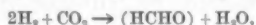
of *Desulfovibrio*. After prolonged incubation a measurable decrease in the volume of N_2 in active cultures was observed, which could not be accounted for by solubility, diffusion, or other processes involving general gas laws. Consequently, helium and argon were tried as controls, both of which proved to be inert. Further investigations, based upon the decreased ratios of N_2/A , confirmed the fixation of N_2 by H_2 -utilizing *Desulfovibrio*.

A pure culture of hydrogenase-producing *Desulfovibrio* was used to inoculate 20 liters of inorganic sea water medium overlaid with 20 liters of gas initially consisting of approximately 80% of catalytically purified H_2 . The remaining 20% of the gas was CO_2 , N_2 , and A, the latter two in a ratio of 1 part of A to 83 parts of N_2 . The composition of the gas was determined periodically by means of mass spectrometer analyses.²

TABLE 1
CHANGE IN COMPOSITION OF GAS CAUSED BY AUTOTROPHIC SULFATE REDUCERS GROWING IN 20 LITERS OF INORGANIC MEDIUM OVERLAYERED WITH 20 LITERS OF GAS AT 28° C

Component	Composition of gas after		
	2 days (%)	42 days (%)	61 days (%)
H_2	82.93	56.04	47.42
O_2	0	0	0
CO_2	0.51	0.27	0.19
H_2S	0	0	0.1
N_2	16.63	43.14	51.61
A	0.20	0.55	0.68
N_2/A ratio	83	78	76

The growth or reproduction of the bacteria was accompanied by a decrease in the H_2 and CO_2 content of the gas phase, as appreciable quantities of these two components were consumed by the autotroph



where (HCHO) represents a primary building block of bacterial cell substance, not necessarily formaldehyde. The content of CO_2 in the gas phase was also affected by the pH of the medium, which became more alkaline as sulfate was reduced to sulfide:



As a result of H_2 and CO_2 uptake, the concentration of N_2 and A in the gas phase increased (Table 1), but the decreasing N_2/A ratio indicated that N_2 was being consumed by the autotrophic bacteria. This was confirmed by determining the absolute quantities of each gas in the closed system. The small amount of H_2S appearing in the gas phase is attributable to its absorption by the slightly alkaline medium.

Four other pure cultures of H_2 -utilizing sulfate-reducing bacteria incubated at 28° C in mineral salts solution overlaid with a mixture of H_2 , CO_2 , N_2 ,

² The mass spectrometer analyses were made by the Richfield Oil Corporation, Wilmington, Calif. The writers also acknowledge the valuable suggestions of D. L. Fox, E. D. Goldberg, and N. W. Rakestraw.

TABLE 2

Culture No.	N_2/A ratio after	
	2 days	60 days
45: 268-1	83	67
45: 268-2	83	76
45: 268-3	83	79
45: 268-4	83	55
None (control)	83	83

and A yielded the results that are shown in Table 2.

These observations, coupled with the observed growth of the bacteria in mineral salts solution containing N_2 as the sole source of nitrogen, establish the ability of another physiological group of bacteria to fix N_2 . Being widely distributed in marine sediments (1, 2), such bacteria may play an important part in the fixation of N_2 in the sea.

The observations help to substantiate the prediction of Lindstrom *et al.* (3, 4) that all hydrogenase-producing bacteria fix N_2 . These workers employed micro-Kjeldahl and tagged-atom (N_2^{15}) techniques to demonstrate the fixation of N_2 by *Chromatium*, *Chlorobacterium*, and *Rhodospirillum* species. We recommend following the N_2/A ratios of gas mixture, which can be easily and accurately determined by mass spectrometer, as an indicator of the ability of bacteria to fix N_2 .

References

1. SISLER, F. D., and ZOBELL, C. E. *J. Bact.*, **60**, 747 (1950).
2. ZOBELL, C. E. *Bull. Am. Assoc. Petroleum Geol.*, **31**, 1709 (1947).
3. LINDSTROM, E. S., BURRIS, R. H., and WILSON, P. W. *J. Bact.*, **53**, 313 (1949).
4. LINDSTROM, E. S., TOVE, S. R., and WILSON, P. W. *Science*, **112**, 197 (1950).

Studies Concerning the Relationship Between Chemical Constitution and Biological Activity in a Group of Reversed Carboxyl (RC) Analogues of Acetylcholine

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This study is directed toward the comparison of parallel derivatives of acetylcholine and its (RC) analogue (1) (methyl- β -trimethylammonium propionate, No. 1 in Table 1). In our previous study we noted the high order of muscarinic activity of the (RC) analogue of acetylcholine with respect to depressor effects, smooth muscle-stimulating action, and salivary

¹ Fellow, American Foundation for Pharmaceutical Education. Portions of the material reported herein were abstracted from a dissertation submitted by H. H. Keasling in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Pharmacology of the College of Medicine and the Graduate College of the State University of Iowa.

TABLE 1

Compound No.	Structure
1	$\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{Br}^-$
2	$\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{C}_6\text{H}_5)_3\text{Br}^-$
3	$\text{C}_2\text{H}_5\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{Br}^-$
4	$i\text{-C}_4\text{H}_9\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{Br}^-$
5	$\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_2\text{CH}_2\text{CH}_2\text{OC}(=\text{O})\text{CH}_3\text{Br}^-$
6	$(\text{CH}_3)_2\text{N}^+\text{CH}_2\text{CH}_2\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_2\text{Br}^-$
7	$(\text{C}_2\text{H}_5)_2\text{N}^+\text{CH}_2\text{CH}_2\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{C}_2\text{H}_5)_2\text{Br}^-$
8	$(\text{CH}_3)_2\text{N}^+\text{CH}_2\text{CH}_2\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_2\text{Br}^-$
9	$\text{CH}_3\text{OC}(=\text{O})\text{CH}(\text{CH}_3)\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{Br}^-$
10	$\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{Br}^-$
11	$\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)_2(\text{C}_6\text{H}_5)\text{Br}^-$
12	$\text{CH}_3\text{OC}(=\text{O})\text{CH}_2\text{CH}_2\text{N}^+(\text{CH}_3)(\text{C}_6\text{H}_5)_2\text{Br}^-$

secretion stimulation. With respect to the enzyme cholinesterase (both true and pseudo), the (RC) analogue of acetylcholine showed negligible substrate susceptibility. It was, therefore, of interest to study the effect of including both the acetylcholine structure and its (RC) analogue structure in the same molecule (see compounds Nos. 5 and 6 in Table 1). We found the material (No. 5) to be about 1/100 as potent as acetylcholine in stimulating the guinea pig ileum and in effecting a depressor response in dogs. Owing to the lack of parallelism of the dose response curves for acetylcholine and No. 5, this is no more than a rough estimate. Much more interesting is the fact that No. 5 is hydrolyzed very readily by true cholinesterase (Winthrop-Stearns' preparation) to the extent of 65% that of β -methacholine. Preliminary studies on the hydrolysis products of No. 5 indicate that the enzyme attacks only the acetyl ester end of this molecule.

No. 6 may also be regarded as a double analogue containing both the acetylcholine and its (RC) arrangements holding the carboxyl group in common. This material possesses muscarinic activity (depressor) in low doses (25 γ /kg to 50 γ /kg in dogs) which

gradually changes to a pronounced stimulating nicotinic action at higher doses (100 γ /kg to 600 γ /kg), even in the absence of atropine. Its muscarinic activity is potentiated after prostigmine, and we were unable to demonstrate any nicotinic depressant activity associated with this substance. The presence of the carboxy group in No. 6 confers upon it muscarinic activity not possessed by the corresponding di-trimethyl ammonium polymethylene analogues studied by Brown *et al.* (2) and Paton and Zaimis (3) and found to be potent nicotinic stimulants. The di-triethyl analogue (No. 7), however, is a potent nicotinic depressant, apparently possessing no demonstrable nicotinic stimulant activity, though it blocks a minimal vagal (depressor) stimulus at 0.5 mg/kg.

Similar to the effects in the acetylcholine series pointed out by Ing (4), the substitution of one ethyl group for a single nitrogen methyl group in the (RC) analogue series (compound No. 11) decreases muscarinic depressor potency to 1/10, and the substitution of two ethyl groups (compound No. 12) decreases the muscarinic potency to about 1/500—both being compared to the (RC) analogue of acetylcholine itself (No. 1).

The (RC) analogues of α - and β -methacholine (Nos. 10 and 9) are no more than 1/10,000 as potent as the corresponding acetylcholine analogues in regard to depressant, gut-stimulant, and salivary secretory actions. They also exhibit negligible cholinesterase susceptibility similar to the (RC) analogue of acetylcholine. On the other hand, in Nos. 3 and 4, the (RC) analogues of propionyl choline, and isovalerylcholine, respectively, potency relationships are reversed. No. 3 is at least 50 times more potent than propionyl choline as a muscarinic and stimulating nicotinic drug, and No. 4 is still more powerful as a stimulating nicotinic agent (giving a marked pressor effect even in the absence of atropine).

The derivative No. 2 possesses depressor activity in the 1 mg/kg to 2 mg/kg dosage range which is blocked by atropine, revealing a low degree of stimulating nicotinic activity. At high doses (12 mg/kg) it tends to act as a weak ganglionic blocking agent, and at intermediate doses it appears to facilitate ganglionic conduction.

Compound No. 8 is a doubled analogue which may be considered as the (RC) analogue of succinyl di-choline. It possesses weak muscarinic activity, but this is greatly overshadowed by its striking curarelike action (about 85% that of D-tubocurarine chloride by the rabbit head drop method). Indeed the intramolecular distance between the nitrogen heads of this material is almost identical with that of decamethylene di-trimethyl ammonium when each is measured in its most extended form.

All the effects so far mentioned refer only to the total response attained by the various agents in the various test preparations. If one takes rate of response to the same total response, acetylcholine is considerably more active in effecting gut contraction than its (RC) analogue. Thus, to reach a final con-

traction of 73% using the guinea pig ileum, acetylcholine and its (RC) analogue require equal doses, but the (RC) analogue requires 250% longer than acetylcholine, and this difference is even more marked at lower dosage levels. In short, although the dose total-response curves are identical within statistical limits, the dose rate-of-response curves are quite different. This brings up the old question: Which—rate of response or final effect—is a more reliable measure of drug receptor fit? Assuming permeabilities and other factors effecting drug transfer to the receptors to be identical for both agents, then acetylcholine appears to “fit” the receptor more readily, as its effect is more prompt. One might, however, argue that the (RC) analogue “fits” just as well, or perhaps better, but it does not so easily gain access to the receptor machinery, thus accounting for the lag in its relative rate of effect. Arguments of this kind, although didactically fruitful, hardly seem profitable at this stage unless operational procedures clarify the questions concerning transfer.

As noted previously (1), the reversal of the carboxyl group of acetylcholine, a modification which leaves over-all molecular dimensions unchanged and also introduces little change in the distance relationships of the oxygen groups to the nitrogen head (5), effected relatively little apparent change in the drug-muscarinic and nicotinic receptor relationships. Actually, however, a fuller notion of the extent of this change becomes apparent in the study of parallel derivatives in the two series. Further, this study indicates that moieties imbedded within a molecular matrix continue to manifest their presence in a pharmacologic sense, though the quantitative expression of their activity is greatly modified by the impedance of other groups. For example, in the double analogues Nos. 5, 6, and 8, the presence of methylated nitrogen heads held in a given relationship to oxygen groups was manifested through a greater or lesser degree of muscarinic activity, even though these analogues are far removed, in a whole molecule sense, from acetylcholine. At first this might seem to be a mere statement of the “whole-molecule-fit” concept in other terms. Actually it represents a quite different point of emphasis, in which the working unit is a group of chemical constitutional characteristics abstracted from various active molecular species and in which other molecular features are thought of as perturbing factors.

This mode of abstraction is, of course, well recognized in other fields. For example, in chemistry we ascribe certain reactions as typical of aldehyde, hydroxyl, and amino groups which are in given compounds impeded or modified to a greater or lesser extent by the presence of other constitutional features of the molecule. One finds it helpful to approach given cases as deviating from the general for various specific reasons rather than as isolated instances. In a similar manner one may visualize the receptor as an entity which places certain positive requirements upon drugs for activity but places no definite negative require-

ments other than that the interaction of the moiety not be impeded. Impedance may take many forms, such as steric interference, the presence of other groups exerting electrostatic field effects that prevent the approach of the molecule containing the moiety to the receptor surface, etc. If, on the other hand, one requires the whole molecule to “fit,” then all parts of drugs Nos. 5, 6, and 8 must find appropriate places on the receptor, and this would necessarily need to be true for all materials possessing muscarinic activity. What a variety of materials this receptor would have to be able to accommodate totally! Returning to the moiety-fit point of view, in terms of a historic example, a given lock may be opened by many different keys provided the given projections of the key are present to turn the given tumblers of the lock. If extra projections are present, these need not also have tumblers corresponding to them in the lock. They merely must not get in the way of the projections that do correspond to the tumblers.

In the present instance, although chemically parallel derivatives in the acetylcholine series and the (RC) analogue series are frequently parallel in their pharmacologic actions, the occurrence of striking deviations from parallelism indicates that the interchange of the components of the carboxyl group effects an alteration in the drug-receptor relationships.

References

1. BARS, W. B., et al. *J. Pharmacol. Exptl. Therap.*, **100**, 465 (1950).
2. BROWN, G. L., PATON, W. D. M., and DIAS, M. V. J. *Physiol.*, **109**, 15 (1949).
3. PATON, W. D. M., and ZAIMIR, E. J. *Ibid.*, **108**, 55 (1949).
4. ING, H. R. *Science*, **100**, 264 (1949).
5. PFEIFFER, C. C. *Science*, **107**, 94 (1948).

A New Versatile Respirator

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The relative merits of the multitude of artificial respirators for animal experimentation may perhaps best be evaluated on the basis of simplicity of construction, ease of control, and versatility of use. The oldest and most widely used design is the electric motor-driven mechanical pump. Only the most complex and expensive custom-built models have any real degree of ease of control and, even then, almost invariably must be stopped to alter the stroke volume which, in turn, is clearly limited by the dimensions of the cylinder. No commercial model has any provision for altering the ratio of time of ventilation to time of exhaust.

In recent years, a number of respirators have been produced which function by opening and closing a valve in an air supply line; these valves, which may be rotary- (1, 2), sleeve-, slide-, or piston-type (3), are, in some models, activated by air-driven motors (1, 2); others are driven by electric motors through

A block diagram (Fig. 1) shows the main components and their relation to one another. The timer may be any of the self-cycling designs which range from double clockwork types to electronic condenser discharge circuits or delay-action relay combinations. Fig. 2 shows the self-cycling timing circuit found to be most satisfactory from the standpoints of stability, simplicity, reliability, and cost. It is entirely electronic and depends upon the time required for a condenser

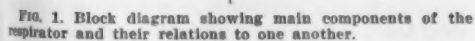
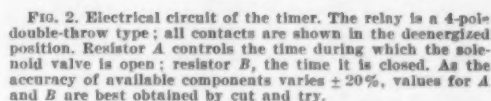


Fig. 1. Block diagram showing main components of the respirator and their relations to one another.



The respirator, working from the standard laboratory air line at 20 lbs pressure has been used for 10 months, and often as long as 24 hr at a time, with complete satisfaction. It has been found to function perfectly with a rat as well as with 2 large dogs simultaneously.

1. MASTERS, A. H. *Quart. J. Exptl. Physiol.*, **20**, 267 (1930).
2. VISSCHER, H. F. *J. Lab. Clin. Med.*, **9**, 197 (1923).
3. BORD, W. R. *J. Lab. Clin. Med.*, **7**, 515 (1933).
4. HOLLAND, K. *Klin. Wochschr.*, **24**, 566 (1947).
5. BURNS, H. L. *Air Surv. Bull.*, **2**, 306 (1945).
6. WEERS, H. *Arch. exptl. Path. Pharmacol.*, **135**, 210 (1928).
7. VISSCHER, M. B., and MULDER, A. G. J. *J. Lab. Clin. Med.*, **15**, 657 (1930).

The West Indian Tree Oyster on the Louisiana Coast, and Notes on Growth of the Three Gulf Coast Oysters

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It has long been known that two species of oysters are present on the South Atlantic and Gulf coasts of the United States: the common commercial species, *Crassostrea virginica* (Gmelin), and *Ostrea equestris* Say.¹ The first is an estuarine species present in great abundance in the bays and forming large reefs in some areas. It is not known to live in the open sea except at one reef just outside Atchafalaya Bay on the Louisiana coast, where the great discharge of the Atchafalaya River keeps the salinity low. In contrast, *O. equestris* is a smaller species living in saltier water and is not often noticed. Like other members of the genus, and in contrast to *Crassostrea*, it has fewer eggs, retains them and the early larval stages, and lacks the promyal chamber. It is not present in great abundance anywhere, although at times it is fairly prolific in some Florida bays. During years when the salinity of certain Texas bays is high, it invades bay waters to a greater extent than usual. In the summer of 1950 over half the spat in some parts of the middle and lower parts of Aransas Bay were *O. equestris*. It has also been reported (1) from shells in the open sea 5 miles off Aransas Pass, which is the westernmost record in the Gulf of Mexico. All *equestris* I have seen in the bays were small, ranging from 2 to 3 cm in length.

In July 1949 I had the opportunity of examining the fouling organisms from the templates of an oil-well platform belonging to the Humble Oil & Refining Company² in the Gulf of Mexico. 5½ miles offshore and 6 miles from the mouth of the Brazos River of Texas. It had been put down July 20, 1948, and was pulled up July 17, 1949, having been in the water almost exactly a year, at a depth of approximately 10 fathoms.

Three *C. virginica* measuring 61-94 mm (3.7 in.) in length were taken from the templates, and several others were present. (The minimum legal length for Texas oysters is 3.5 in.) When the oyster set is not known, but granting that it set the day the platform was completed, then the average daily growth rate for the year was 0.26 mm. This figure is a minimum, and if the oyster set later then the growth rate was faster. The oysters were in good condition, unlike the usual

summer oysters of the bays. Another noteworthy fact was the absence of boring clams, boring sponges, and mudworms, the shell-boring associates. Furthermore, the shell was thin and smooth. So far as is known, *C. virginica* does not live in the Gulf of Mexico off the Texas coast, and presumably the larvae came from the bays 6 miles away. The oysters were found within 12 ft of the surface.

Also present on the templates were several *O. equestris*, which were found from 12 ft down to the mudline. Nine specimens ranged from 28 to 55 mm in length, averaging 44.1 mm. Some of them were ripe, but larvae were not seen.

On February 15, 1950, I examined templates from a Louisiana platform belonging to the Humble Oil & Refining Company, which had been pulled on February 12 after being in the water 10 months and 10 days. It was located at 29°08'08"N, 89°38'51"W, approximately 5 miles SE of Barataria Pass, in 50 ft of water.

Ten *C. virginica* ranging from 47 to 92 mm in length were taken from this platform. The average length was 81 mm. The minimum growth rate of the largest oyster was 0.30 mm/day. Thirty-three *O. equestris* were also taken, ranging from 35 to 72 mm, or 2.8 in., in length. The minimum growth of the larger *equestris* was 0.23 mm/day. In addition, 54 specimens of the West Indian tree oyster, *Ostrea frons* (Linnaeus), were taken from the templates. They were from 38 to 58 mm in length, and the minimal daily average growth rate was 0.19 mm. Typical West Indian examples of this species have prongs, or hooks, on the lower valve growing around and sometimes interlocking over mangrove roots. On the Louisiana tree oysters there were faint remnants of hooks near the hinge. Woodring (2) has pointed out before that tree oysters do not necessarily develop hooks when growing on flat surfaces.

This is the first report of tree oysters on the northern Gulf Coast. Similarly, so far as is known, it is the first time the 3 species named have been found growing together in one locality or on one structure. However, the oil-well platforms are the first permanent vertical structures erected in the Gulf at these depths, with the exception of some buoy chains, and the oysters grew at overlapping but different levels, with the common oyster nearer the surface, where the waters are less saline.

Geyer (3) shed considerable light on offshore Gulf salinities when he showed that waters at a mean depth of about 10 ft around oil-well platforms, 6-8 miles off the Louisiana coast, undergo marked seasonal, as well as pronounced short-period, variations ranging seasonally from 15 to 35 per mill. This explains how the common oyster of the bays can live on the upper levels of oil-well platforms in the shallow Gulf, whereas *equestris* and tree oysters, with less tolerance of low salinity, live in the saltier depths. Since tree oysters have not previously been found in the northern Gulf, one wonders where the larvae came from. Most probably the tree oysters live on and around the small coral heads and lumps found in these offshore waters.

¹ *O. equestris* Say has recently been synonymized with *O. cristata* Born, of South America, by some workers in this country. Gilbert Ranson examined the cotypes of *equestris* in Philadelphia and the type of *cristata* in Vienna and recently informed me that the two are quite different. The proper name, therefore, of this little oyster of the South Atlantic and Gulf coasts is *O. equestris* Say. *O. spreata* d'Orbigny is a synonym.

² The writer is indebted to the Humble Oil & Refining Company, and to R. A. Geyer of that company, for the opportunity to make these observations.

Ingle (4) has shown that the daily growth rate of Florida oysters in May and June may vary from 0.3 to 1.3 mm per day. The higher figures are doubtless daily maxima not maintained over the year, for otherwise oysters would attain a length of 12 in. in a year's time. Both his data and those presented here show, however, that the daily increment of shell on oysters in Southern waters is surprisingly high.

References

1. GUNTER, G. *Publ. Inst. Marine Science*, 1, (2), 7 (1950).
2. WOODBRING, W. *Carnegie Inst. Wash. Pub.*, No. 366 (1925).
3. GETEY, R. A. *J. Marine Research*, ix (July, 1950).
4. INGLE, R. M. *Science*, 112, 338 (1950).

Organic Origin of Some Calcareous Sediments from the Red Sea^{1,2}

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This note describes a preliminary attempt to decipher the origin of the calcareous part of the finer fractions of some samples collected from the northern part of the Red Sea during a voyage of the R.R.S. *Mabaheth* in 1934-35.

Shukri and Higazy (1, 2) have discussed the distribution, general character, and mineralogy of the samples collected by the expedition, and certain of their special features have been studied by Mohamed (3, 4) and Said (5, 6). The submarine topography of the Red Sea basin has been considered in detail by Crossland and Badr (7).

The Recent Red Sea sediments are whitish "coral muds" of high CaCO_3 content. The coarse fractions of these samples ($> 20 \mu$) consist largely of fragmentary organic remains (as determined volumetrically under the binocular microscope: 80% corals, 5% foraminifera, 15% echinodermata, mollusca, calcareous algae, etc.). In this investigation only fractions finer than 20μ were separated by ordinary settling methods for study. The carbonate content of these finer fractions was determined by acid leaching. It was found that the carbonate proportions in them were the same as in the bulk samples. The finer fractions were then separated in bromoform. The lighter portion, composed mainly of calcareous material, together with small amounts of clay, quartz, and feldspar, were dried and weighed. The latter accessory components in no case exceeded 3% by weight.

Spectrochemical analyses of the light part of the finer fraction of sample No. 17, and of a fragment of coral picked from the bulk sample, were made by H. C. Harrison, of the Rhode Island State College, to whom grateful acknowledgment is given. Tables 1 and 2 present the results of these determinations.

The analyses show that the calcareous part of the

TABLE 1

DISTRIBUTION OF ELEMENTS IN SAMPLES

	1*	2*		1*	2*		1*	2*
Si	B-	B	Au	X	X	B	E	E-
Al	C-	C	Ba	E	E	Ce	X	X
Fe	D-	C-	Li	X	X	Y	X	X
Mg	B-	B	Sr	B+	B	Nd	X	X
Ca	A	A	Rb	Not		La	X	X
Na	B	B-		determined		Gd	X	X
K	Both less		Cs	Not		Pr	X	X
	than 0.1%			determined		Se	X	X
Mn	E	D-	Hg	X	X	Ho	X	X
Re	X	X	Zn	X	X	Dy	X	X
Ti	E	E+	Cd	X	X	Yb	X	X
Zr	X	X	Ga	X	X	Er	X	X
Hf	X	X	In	X	X	Eu	X	X
Th	X	X	Tl	X	X	Tb	X	X
Pb	F+	F+	Co	X	X	Lu	X	X
Sn	X	X	Ni	X	X	Tm	X	X
Ge	X	X	Pt	X	X	Sm	X	X
Cr	E	E-	Ir	X	X	S	Not	
Mo	X	X	Os	X	X		determined	
W	X	X	Pd	X	X	P	Both less	
U	X	X	Rh	X	X		than 0.01%	
V	E-	E-	Ru	X	X	F	Not	
Cb	X	X	Be	X	X		determined	
Ta	X	X	As	X	X	Te	Not	
Cu	E-	E-	Sb	X	X		determined	
Ag	F-	F-	Bi	X	X			

1* Coral fragment.

2* Calcareous part of the finer fraction of sample 17, *Mabaheth* expedition.

+ Higher end of concentration range.

- Lower end of concentration range.

X Sought but not found.

TABLE 2

SUMMARY OF DISTRIBUTION OF ELEMENTS IN SAMPLES

	A (over 10%)		B (10-1%)		C (1-0.1%)		D (0.1-0.01%)		E (0.01-0.001%)		F (< 0.001%)	
1*	Ca	Si, Mg, Na, Sr	Al	Fe	Mn, Ti, Cr, V, Cu, Ba, B	Pb, Ag						
2*	Ca	Si, Mg, Na, Sr	Al, Fe	Mn	Ti, Cr, V, Cu, Ba, B	Pb, Ag						

finer fraction of the sample is almost identical in composition to that of the coral. The sample, however, contains higher percentages of Si, Al, and Fe, which is quite expectable since it was impossible to remove all the clay and other light minerals. The fact that V, B, Ag, Pb, and other trace elements exist in the calcareous part of the finer fraction, as well as in the coral, strongly suggests that the sediment owes its origin for the most part to the accumulation of abraded organic remains. The fact that corals comprise 80% of the bulk sample, and that the spectrochemical analysis of the individual coral sample closely resembles the finer fraction, seems to indicate that such

¹This work was done during the summer of 1950 while the author was working under a fellowship awarded him by the Woods Hole Oceanographic Institution.

²Contribution No. 540, from the Woods Hole Oceanographic Institution.

organisms have contributed the largest amount of the calcareous part of the finer fraction. Some other organisms, however, may also have contributed, since additional spectrochemical analyses made for comparison did not differ greatly from that of the finer fraction (*cf.* [8]). The data did not completely preclude the possible existence of chemically precipitated carbonate in the sediment, however.

The conclusion that the sediments are largely organic in origin seems most significant in view of the fact that Red Sea oceanographic conditions should be, according to many proponents of the chemical deposition of CaCO_3 (9-11), ideal for such a mode of accumulation. First, the temperature of the entire water column is high throughout the year and seldom falls below 22°C even at depth during the winter. Second, the salinity ranges from 40‰ to 41‰ , which is exceptionally high and is, in fact, among the highest recorded in any existing open sheet of water. Third, the diversified topography of the bottom varies from large shallow flats to deep and highly irregular basins. Fourth, the coast is reef-bound, and a tremendous supply of CaCO_3 nuclei should be present as the result of normal marine erosion and attrition. Fifth, although the phytoplankton is not too abundant, it is by no means inconsiderable. Sixth, some areas are continuously agitated; others essentially undisturbed. From the evidence here cited that these Red Sea sediments do not possess significant quantities of chemically precipitated CaCO_3 , it seems valid to conclude that chemical deposition of CaCO_3 is negligible, at least in the present-day seas.

The optimum conditions for formation of calcareous deposits in the Recent seas are: (1) an environment conducive to proliferation of CaCO_3 shell-building organisms, (2) conditions under which large quantities of contaminating terrigenous materials are prevented from reaching basins of deposition, thereby masking the calcareous organic debris. For example, basins with reef-bound coasts and virtually no runoff because of aridity are probably the most favorable environments for accumulation of carbonate deposits. In the Red Sea itself, the carbonate percentage increases progressively offshore, irrespective of depth. It seems, therefore, that influx of terrigenous material, normally maximum near shore, reduces the total relative carbonate percentage.

It may also be worth while to note that the mineralogy of the finer calcareous fractions of the samples studied, as determined by x-ray diffraction measurements, indicate they are mainly calcite, with very little aragonite. This observation is of interest, as the coarser calcareous fractions from which the fine fractions are derived consist largely of aragonite (2). It seems, therefore, at least in the Red Sea, that inversion of aragonite to calcite requires not too much time during abrasion and transport. The stability of aragonite has long been a controversial subject, but these observations of the Red Sea sediments add evidence of the facility with which aragonite inverts to calcite under the described conditions.

References

1. SHUKRI, N. M., and HIGAZI, R. A. *J. Sediment. Petrology*, **14**, 43 (1944).
2. *Ibid.*, 70.
3. MOHAMED, A. F. *Proc. Roy. Soc. (London)*, **B**, **128**, 306 (1940).
4. ———, *Am. J. Sci.*, **247**, 116 (1949).
5. SAID, R. *Spec. Pubs. 26*, Cushman Lab. Foram. Research (1949).
6. ———, *Contribs. Cushman Found. Foram. Research*, **1**, 9 (1950).
7. CROSSLAND, C., and RADR, A. *Publ. Marine Biol. Station, Ghardaqa (Red Sea)*, **1** (1939).
8. SAID, R. (In press.)
9. CLOUD, P. E., and BARNES, V. E. *Univ. Texas Pub.* **4621**, 79 (1946).
10. SVERDRUP, H. U., et al. *The Oceans*. New York: Prentice-Hall (1946).
11. WATTENBERG, H., and TIMMERMAN, E. *Ann. Hydrogr. u. Marine Meteorol.*, **64**, 23 (1936).

A Tissue Culture from Potato Tuber: The Synergistic Action of 2,4-D and of Coconut Milk¹

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The conditions that enable actively proliferating tissue cultures to be established from otherwise mature nongrowing cells are of interest because they may contribute to an understanding of normal and abnormal growth—or furnish material by which the differences between growing and nongrowing cells may be investigated. Our work with these systems has been in progress for some time. This note describes a technique by which it has been possible to establish an actively growing tissue culture from the parenchyma of the potato tuber.

Proliferation of the parenchyma beneath lenticels is a familiar feature of cut potato tubers kept in a very moist atmosphere. Nobécourt (1) attempted to obtain a tissue culture from slices of potato tuber kept either on moist cotton or on an agar surface. These tissue slices were relatively large (250 mg), and although proliferation occurred and protuberances formed, the relative growth was small (the fresh weight doubled in 4 months). We, however, have established, apparently for the first time, actively growing tissue cultures from potato tuber which increased in fresh weight approximately 50 times in 5 weeks, and subcultures from these continue to grow actively. The technique by which this was accomplished has obvious and far-reaching implications. It seems appropriate, therefore, to describe it here.

The mature parenchyma cells of the potato tuber are certainly able to divide. When cut slices are exposed to moist air, the cell divisions near the surface lead to the formation, within the mature parenchyma, of a cork phellogen. Henceforward, the divisions of this cambium are orderly, but the behavior of the cells

¹ This work was carried out with the aid of a grant to one of us (F.C.S.) from the Cancer Institute of the National Institutes of Health, U. S. Public Health Service.

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cut off by the cambium is circumscribed: the outer ones differentiate to form dead cork cells, the inner ones (fewer in number) remaining alive, though they mature and cease to divide. It is well known that Haberlandt (2) postulated quite early that this response of the cells of the potato tuber was stimulated by the then hypothetical wound hormone. He also believed that unless a small piece of tissue contained at least some sieve tubes (supposed to be the source of the hormone) they would not heal.

Later Bonner and English (3) claimed that the substances they called traumatin (1-decene-1,10-dicarboxylic acid) stimulated cell divisions in the young, inner epidermis of bean pods. They stated that this substance occurred in a variety of plants, including potato, but they did not themselves record any data which demonstrate that this substance stimulates cell division in potato cells.

Some time ago we attempted to establish a sterile, proliferating tissue culture, using the mature parenchyma of the potato tuber. We had found coconut milk to be successful in stimulating the mature secondary phloem of the carrot root into active growth (4). This fluid contains some growth factor, or combination of factors, which is designated, pending its

TABLE 1

GROWTH IN FRESH WEIGHT¹ OF 3-MG EXPLANTS FROM POTATO TUBER AT 26° C DURING 5 WEEKS IN ASEPTIC NUTRIENT SOLUTIONS SUPPLEMENTED BY 2,4-D AND COCONUT MILK

Coconut milk (% by vol)	Mg/liter 2,4-D					
	0	0.3	1	3	6	18
0	2.7	3.1	2.4	3.1	2.5	3.2*
0.3	3.4	6.3	5.4	6.3	4.8	3.3
1	2.6	7.4*	16.4**	21.0**	43.2**	11.1
3	3.6*	30.0*	32.5*	47.7**	44.8*	38.0**
6	5.7*	39.6	56.5*	90.9**	81.2**	44.3*
18	9.0**	93.7*	102.8**	156.3**	164.0**	68.4

¹ Fresh weight data represent mean of 5 replicates, except where indicated as follows: * mean of 4, ** mean of 3, *** mean of 2.

isolation and identification, as the coconut milk factor (CMF). Although the CMF was effective in stimulating cells from other plants into active growth (e.g., Jerusalem artichoke tuber), it had no appreciable effect upon potato tuber tissue, which did not grow even when in contact with the medium (basal medium supplemented by coconut milk) that supported rapid growth of carrot cells. Attempts were made to stimulate the potato cells into an actively proliferating tissue culture by other means. Among these, treatment with traumatic acid and 2,4-D (2,4 dichlorophenoxyacetic acid) solutions was tried. So far as our experiments went, the former substance produced no appreciable effect as measured by continued increase of fresh weight, whereas the latter, when added to the nutrient medium, caused a real and provocative increment of fresh weight, which did not continue (maximum effect at 7.0 mg/liter). Even so, 2,4-D

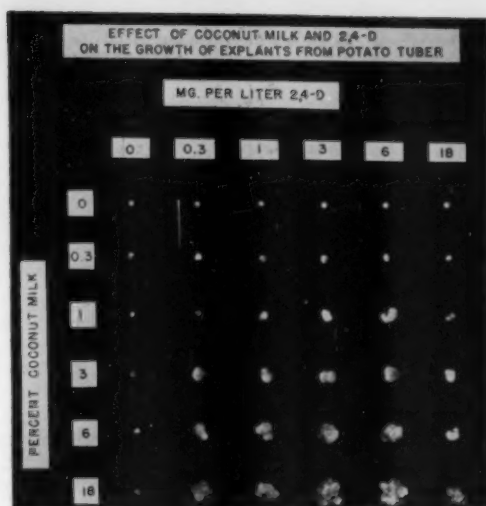


FIG. 1.

alone did not lead to a culture able continuously to grow and divide.

Fortunately we were led to try the effect in combination of coconut milk and 2,4-D. Whereas either substance alone produces only slight effects on the potato cells, and neither will stimulate the tissue into active proliferating growth, in combination they act as a powerful stimulus to growth. This is shown by the following data.

Explants (individually weighing about 3.0 mg) were removed aseptically from the medulla of the tuber, using a surgical cannula and a device to cut the cylinders so removed into standard lengths. For these experiments, the medulla was used because it was easier to obtain a large number of explants from one tuber. The cortex, however, responds in a similar but essentially more uniform manner to the medulla. The growth of the small cylindrical explants was then tested by exposing them to the basal medium (4) supplemented by coconut milk and/or 2,4-D.

Experiments have been made with explants grown on the surface of nutrient agar in tubes, but the more instructive data were obtained when the tissue cultures were grown under the special conditions that have been found suitable for carrot tissue (5). Under these conditions, the tissue is exposed alternately to air and liquid in special tubes slowly revolved (1 rpm) around a shaft slightly inclined to the horizontal.

The data in Table 1 and Figs. 1 and 2 show the results of a symmetrical experiment in which the growth of the cultures was measured in 36 different solutions. The effect of coconut milk alone is shown by the growth in the basal medium supplemented by 0, 0.1, 1, 3, 6, and 18% by volume of sterilized, filtered coconut milk. The effect of 2,4-D alone is shown by

EFFECT OF 2,4-D AND COCONUT MILK
ON GROWTH OF EXPLANTS
FROM POTATO TUBER

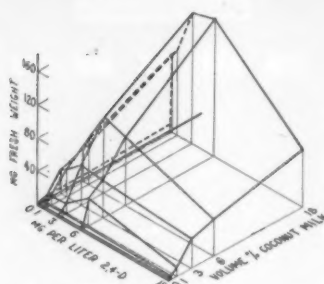


FIG. 2.

the growth in the basal medium supplemented by 0, 0.1, 1, 3, 6, and 18 mg/liter of 2,4-D. The interaction of the CMF with 2,4-D is shown by the growth in media containing both supplements in all the possible combinations of the dosages shown above.

The conclusions are self-evident from Fig. 1, which shows a representative culture harvested after 5 weeks from each treatment. Table 1 describes the growth in terms of the mean fresh weight of the cultures. In Fig. 2 these data are shown plotted on isometric paper. Occasional cultures that were not viable (for unknown reasons) were omitted when calculating the means. (Even including these, however, does not appreciably affect the results.)

Briefly, the conclusions are these. At zero, or very low, concentrations of coconut milk, the effect of 2,4-D on growth is small, and the specific effect of its concentration is also small. At zero, or very low, concentrations of 2,4-D, the effect of coconut milk is negligible at all concentrations. Cultures, however, in contact with both 2,4-D and the CMF grew, and the solid surface depicted in Fig. 1 shows that the optimum concentration of 2,4-D is of the order of 6 mg/liter. At this concentration of 2,4-D the tissue shows the maximum response to concentration of the CMF, and even at 18% by volume of coconut milk the limit of response has not been reached.

One further point should be stated. The experiment described in Table 1 and in Figs. 1 and 2 lasted some 5 weeks. For a relatively large part of this period (10-14 days) the tissue made but little growth. The significance for the future growth of this lag, or induction, period has yet to be investigated.

The implications of this work are clear. Whereas CMF alone may be a powerful tool in stimulating some cells into active growth, it is of no avail in some cases. At least in some such cases, the reason is that the cells cannot respond to CMF because their growth is also limited in some manner that requires the intervention of 2,4-D, or a similarly acting substance. Since the response to CMF is so clearly a function of the concentration of 2,4-D and vice versa, these two distinct stimulants appear to act synergistically on the

cells of the potato tuber. Understanding of these relations may be expected to shed light both on the mechanism of the CMF on cells and also on the mechanism of the action of 2,4-D.

In view of the reported (6) but disputed (7) effect of onion juice to increase the growth-promoting activity of auxin or 2,4-D, experiments were conducted to test this further. Potato cultures were grown with combinations of onion extract and 2,4-D added to the medium. The results obtained clearly indicated that onion juice could not substitute for coconut milk. Also at relatively small concentrations (juice of 0.1 g of onion tissue/100 ml of culture medium) onion juice inhibits the growth of carrot even in the presence of the CMF.

The combined action of CMF and 2,4-D on cells of the potato furnishes a system of growing, randomly proliferating, cells that may be contrasted with the cells of the resting tuber, or with the metabolically active cells at the surface of a tissue slice which have, however, only a more limited ability to grow. When these contrasts are described in terms of protein synthesis, salt accumulation, and respiration, we should know more about the physiological characteristics of growing and nongrowing cells.

References

1. NORECOURT, P. *Bull. soc. botan. France*, **85**, 490 (1938).
2. HABERLANDT, G. *Sitzber. preuss. Akad. Wiss., Physik.-math. Klasse*, **1**, 318 (1913); **2**, 1096 (1914); **6**, 221 (1921).
3. BONNER, J., and ENGLISH, J., JR. *Plant Physiol.*, **13**, 331 (1938).
4. CAPLIN, S. M., and STEWARD, F. C. *Science*, **106**, 655 (1948).
5. ———. *Nature*, **163**, 920 (1949).
6. LUCAS, E. H., and HAMNER, C. L. *Mich. State Coll. Agr., Agr. Expt. Sta., Quar. Bull.*, **29**, 256 (1947).
7. SPEAR, I., and THIMANN, K. V. *Plant Physiol.*, **24**, 587 (1949).

Factors Involved in Blood Clearance of Bacteria¹

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It was recently reported (1) that the injection of an antigen into a rabbit previously immunized to that antigen was followed in 15-30 min by a pronounced reduction of the hemolytic complement of the serum. Also observed were the previously noted phenomena of the so-called negative phase, including decreases in specific antibody (2), granulocytes, and platelets (3), and in the coagulability of the blood (4). Evidence was presented (1) to support the concept that the decrease of complement was due to the fixation of complement by an *in vivo* complex of extracellular antigen and extracellular antibody. It was suggested that this specific reaction might be applied to the experimental reduction of complement *in vivo* in order

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TABLE 1
EFFECT OF INJECTION OF AN ANTIGEN INTO AN IMMUNIZED RABBIT ON
SUBSEQUENT BLOOD CLEARANCE OF SHIGELLA

Rabbit No.	Time (p.m.)	Treatment	Organisms/ml blood	Complement titer (in ml)*	Polymorphonuclear cells (%)	Lymphocytes
4 A Normal	2: 00	Bled	—	0.6	45	50
	2: 01	1 ml <i>Shigella</i> IV	—	—	—	—
	2: 02	Bled	21,000	0.61	45	50
	2: 17	"	0	0.6	42	50
	2: 32	"	0	0.6	42	50
67 immunized to BGG†	2: 30	Bled	—	0.52	30	65
	2: 35	1 ml 2% BGG IV	—	—	—	—
	2: 50	Bled	—	4.1	0	98
	2: 51	1 ml <i>Shigella</i> IV	—	—	—	—
	2: 51½	Bled	18,000	—	—	—
	3: 06	"	15,000	4.0	5	95
	3: 21	"	10,000	2.5	15	85
	3: 36	"	8,000	1.2	30	62
	4: 06	"	400	0.5	41	59

* Complement titer = ml 1:10 rabbit serum required to hemolyze 50% of sensitized cells; the larger the figure, the smaller the concentration of complement in the sample.

† BGG = Bovine gamma globulin.

to determine the effect of such a reduction on host resistance. The present study is concerned with the effect of the reinjection of an antigen on the clearance from the blood of an antigenically unrelated particulate antigen (two species of bacteria).

The phagocytosis of bacteria by reticuloendothelial cells (5) represents a fundamental mechanism whereby the host deals with bacteria that have gained access to the circulation. This phenomenon was selected for study for two reasons: (1) it would appear to furnish an *in vivo* phagocytic system that could be easily studied and quantitated, and (2) clearance occurs rapidly and, therefore, lends itself well to study in conjunction with the rapidly occurring *in vivo* reductions of complement, granulocytes, and platelets.

The basic experiment consists in the comparison of the number of bacteria removed from the circulating blood of a normal rabbit and from the blood of a rabbit immunized against bovine gamma globulin and injected with the globulin 15 min before the inoculation of bacteria. Both the antigen and the bacteria were inoculated intravenously into the marginal ear vein. Blood cultures were made by taking up 0.1 ml of blood into a tuberculin syringe by cardiac punctures at appropriate intervals and spreading the blood on tryptone agar plates either directly or after dilution with saline. Parallel samples were taken for blood counts, smears, and determinations of the hemolytic complement activity (6) of the serum. The organisms selected for the clearance observations included the gram-positive *Micrococcus candidus* and the gram-negative *Shigella paradyserteriae flexneri*.

Table 1 illustrates the representative findings of such an experiment. The normal animal rapidly reduced the number of circulating bacteria. The immunized animal, which received homologous antigen shortly before injection of the bacteria, accomplished

this reduction much more slowly and incompletely. The results were similar with the *Shigella* and *Micrococcus*. Thus far the interference with clearance of bacteria has been noted in 22 immunized rabbits that were given antigen before inoculation.

One other feature of these experiments is worthy of note. It was occasionally found that rabbits immunized with bovine globulin, which had not been inoculated with the *Shigella*, nevertheless possessed "natural" or spontaneously acquired agglutinins for this organism in low titer. When the "negative phase" was induced in such rabbits, and *Shigella* then introduced intravenously, the animals cleared the circulation of the bacteria as rapidly and completely as did the normal rabbits.

The mechanism of the interference with blood clearance is not known at this time. It would, of course, be most tempting to link the inhibition of clearance with the drop in complement, but alternative explanations are possible. Indeed, this inhibition may not even be related to any of the associated phenomena of the early "negative phase." The data obtained to date tend to eliminate specific bacterial antibody and coagulability of the blood as factors involved in the delayed blood clearance. Repeated serological tests have shown that most of the rabbits did not possess agglutinins against the bacteria; when such spontaneous antibodies were found, as previously noted, injection of the antigen did not affect clearance of the organisms from the blood.

To determine the role of coagulability of the blood, heparin was injected intravenously to simulate the rise in this substance believed to occur during anaphylactic shock (7). Up to 20 mg of heparin had no effect on the clearance. The effect of heparin on the suppression of clearance following reinjection of an antigen has not been determined.

These studies on the mechanism of suppression of blood clearance are being continued in the hope that they will contribute ultimately to a better understanding of the factors involved in blood clearance itself.

Addendum: After this manuscript was submitted for publication, a colleague called the author's attention to a paper by D. Weisberger (*Proc. Soc. Exptl. Biol. Med.*, 29, 445 [1931]). Dr. Weisberger observed a prolonged *Streptococcus viridans* bacteremia in rabbits sensitive to horse serum, whereas normal rabbits cleared the blood rapidly. He did not study the mechanism of the phenomenon.

References

1. STAVITSKY, A. B., STAVITSKY, R., and ECKER, E. E. *J. Immunol.*, **63**, 389 (1949).
2. CULBERTSON, J. T. *Ibid.*, **28**, 279 (1935).
3. KINSSELL, L. W. *et al. Ibid.*, **42**, 35 (1941).
4. RATNER, B. *Allergy, Anaphylaxis, and Immunotherapy*. Baltimore: Williams & Wilkins (1943).
5. WILSON, G. S., and MILES, A. A. *Principles of Bacteriology and Immunology*. Baltimore: Williams & Wilkins (1946).
6. ECKER, E. E., HIATT, C. W., and BARR, L. M. *J. Lab. Clin. Med.*, **32**, 287 (1947).
7. JAGUES, L. B., and WATERS, E. T. *J. Physiol., London*, **99**, 454 (1941).

The Use of Ion Exchange Resins with Flavonoid Compounds¹

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Ion exchange resins have been found to be of much value in our laboratory in the isolation, separation, and purification of flavonoid compounds. Examples of such applications to be described include the isolation and purification of homoeriodictyol from yerba santa and the removal of quercetin from commercial samples of rutin.

Pyrex columns, 2" × 48", were packed with a 2-in. layer of glass wool, followed by 2 in. of purified sea sand, and then filled to a height of 36 in. with a slurry of Amberlite IRC-50(H) synthetic cation exchange resin.² The columns were downwashed with 4 liters of 2% HCl, backwashed with distilled water, and finally downwashed with distilled water until the washings were neutral.

Isolation and purification of homoeriodictyol. Five hundred g of powdered yerba santa leaves³ was successively extracted with three 10-gal portions of boiling distilled water in 2-hr periods. The last extract gave only a very weak test for flavonoid materials. The extracts were filtered through a flannel bag and passed through 2" × 48" glass columns packed with Amberlite IRC-50(H) cation exchange resin. Five gal of the extract was passed through each column at a rate of 2 gal/hr.

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² The Resinous Products Division, Rohm & Haas Company.

³ S. B. Penick and Company.

The columns were washed with distilled water as long as any color was removed (about 4 liters/column). The flavonoid material was then eluted by washing each column with approximately 1½ liters of ethyl alcohol. The alcohol solutions were combined, concentrated to 3½ liters in a flash evaporator, diluted with 2½ liters of water, and set in the refrigerator. A brownish-colored tarry mass of crude homoeriodictyol (5,7,4'-trihydroxy-3'-methoxyflavanone) separated from the solution on standing.

The solution was filtered, and the tarry residue extracted with 1,200 ml of ethyl ether. The ether solution was decanted from a small amount of undissolved black solid and shaken with four 50-ml portions of 10% ammonium carbonate solution (1). This treatment removed a considerable amount of acidic tarry materials. The homoeriodictyol was then precipitated as the insoluble sodium salt by extracting the ether solution with five 90-ml portions of 10% sodium carbonate solution. The sodium homoeriodictyate was collected by filtration of the sodium carbonate solution and washed with a small quantity of distilled water.

The sodium salt was dissolved in 3 liters of distilled water and passed through a column of Amberlite IRC-50(H) resin. A bright-yellow band of homoeriodictyol formed at the top of the resin bed as the complex was decomposed by hydrogen-sodium exchange. As further solution was passed through the column, the band broadened in width. The column was washed with 3 liters of distilled water, by which time the filtrate was clear and colorless. The homoeriodictyol was then eluted from the column with ethyl alcohol. The alcohol solution was concentrated to approximately 600 ml and then diluted with an equal volume of distilled water. A pale-yellow precipitate of homoeriodictyol separated on standing in the refrigerator. Yield 14.0-14.5 g, or 2.8-2.9%.

Paper partition chromatography (2) of the final product revealed no evidence of contamination by eriodictyol or other flavonoids. Mixed chromatograms and mixed melting point determinations with authentic homoeriodictyol substantiated the purity and identity of the product.

Purification of rutin. Commercially available rutin (3,5,7,3',4'-pentahydroxyflavone-3-rhamnoglucoside)⁴ usually contains a small quantity of quercetin (3,5,7,3',4'-pentahydroxyflavone). Paper partition chromatography of the rutin used in this experiment indicated the quercetin content was of the order of 1%.

Two g of rutin was dissolved in 3 liters of boiling water, and the resulting solution was quickly cooled to room temperature. The solution was passed through an ion exchange column packed with Amberlite IRC-50(H) and followed by 1 liter of distilled water. A light-yellow band of color extended ⅓ of the distance down the column. The water wash was allowed to drain from the column until level with the top of the resin bed. Three liters of 20% isopropyl alcohol-80% water was then passed through the column at a flow rate of 60-70 ml/min. The isopropyl alcohol-

⁴ S. B. Penick and Company.

water solution slowly moved the yellow band of color down the column. The alcohol solution was followed through the column by distilled water in order to flush the last of the alcohol through the resin bed. The alcohol-water eluate was concentrated at reduced pressure to 600 ml, and the sample set in the refrigerator overnight to allow precipitation to occur. The precipitate was collected and dried at 110° C. One and eight-tenths g of rutin was recovered from the column.

Paper partition chromatography of the recovered rutin revealed no fluorescent zone of quercetin in contrast to the easily detectable zone of quercetin in paper chromatograms of the original sample. The quercetin was subsequently recovered from the column by elution with 95% ethyl alcohol. Paper partition chromatography of the concentrated ethyl alcohol fraction revealed a small amount of rutin present along with the quercetin.

Preliminary studies indicate promising possibilities for expanding the applicability of ion exchange resins to flavonoid compounds through the use of ion exchange resins other than the Amberlite IRC-50. The flavonoids may also be adsorbed on the hydrogen form of Amberlite IRC-50 from solutions of their sodium, potassium, lead, or aluminum salts. Metal ion-hydrogen ion exchange occurs on the resin bed, and the adsorbed flavonoid may be subsequently eluted with alcohol.

References

1. GEISSMAN, T. A. *J. Am. Chem. Soc.*, **62**, 3258 (1940).
2. WENDER, S. H., and GAGE, T. B. *Science*, **109**, 287 (1949).

Alteration of Immunological Response in Malignancy: Decline of *Proteus* Agglutinin¹

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In a recent study (1) focused on the course of non-specific antibody in malignancy, we observed a fall in the *Proteus* agglutinin of chicken sera throughout the development of a Rous sarcoma. This finding, supported by literature indicating a lessened incidence of antibody in malignant disease, stimulated our interest and provoked our current investigation of antibodies to *Proteus* in human sera under normal and neoplastic conditions, of which we are now submitting a preliminary report.

Proteus agglutinin was selected as particularly convenient for our purpose since we found it to be

quite common to normal adults. For all titrations described below the antigen used was a *Proteus* vaccine prepared from the OX19 strain according to our method described elsewhere (1). Before testing, the stock solution of antigen was diluted 10-15 times with saline, depending upon trial tests necessary to determine the dilution that would give agglutination with normal but not with cancer sera. As a normal control we used a pooled sample of sera from individuals with no apparent disease, and for a negative control, serum from a patient with a proved malignancy.

The actual test was done in small tubes (1.2 cm x 10.1 cm) stoppered with cork to prevent evaporation. To each tube containing 0.1 ml of inactivated serum (56° C for 30 min), whether undiluted or in dilution, we added 0.1 ml of our antigen. The tubes were incubated at room temperature and read with the aid of a binocular microscope (10x and 23x) at several time intervals over a 2-hr period. We observed that the human sera which agglutinate with *Proteus* antigen give a strong reaction when used undiluted or diluted 1-10 times. Most normal adults give a strong positive reaction, whereas infants and children fail to react at all. The latter finding corresponds to our results with the sera of chicks less than 1 month old, and merely reflects the slow development of antibody in the young.

TABLE 1
INCIDENCE OF *Proteus* agglutinin IN NORMAL
HUMAN SERA

Group	Positive agglutination	No agglutination
Infants to 1 yr	1	13
Children 1-5 yrs	7	3
Donors (normal)	41	2
Pregnant women	14	1

Table 1 lists various normal groups and for each group the number of sera tested that agglutinated with the *Proteus* antigen contrasted with the number that did not. In infants under 1 year 1 out of 14 agglutinated, whereas in children from 1 to 5 years, 3 of 10 gave a positive reaction. It is of particular interest that in the adult groups 95% were found to have agglutinins to *Proteus*, and this includes 14 of the 15 pregnant women tested.

To continue our study we obtained sera from the Clinics and Tumor Registry of the Grace-New Haven Community Hospital and had them tested for *Proteus* agglutination by a technician. When the clinical diagnoses were received 3-4 months later the results were compared with the findings of the clinicians and are summarized in Table 2 according to a diagnosis of malignancy² or nonmalignancy, omitting 6 cases where the final diagnosis was questionable.

From Table 2 it may be noted that the sera from patients with various nonmalignant diseases gave an

¹ This investigation was supported by grants from the Division of Grants and Fellowships of the National Cancer Institute (USPHS), the American Cancer Society, the Jane Coffin Childs Memorial Fund for Medical Research, and the Damon Runyon Fund for Cancer Research.

² National Cancer Institute special research fellow.

² Established by biopsy.

80% agglutination with *Proteus* antigen, whereas patients with a neoplastic growth, reported to us as untreated for their malignancy, showed an incidence of agglutination of only 28%. Statistically our value for t is 5.7, and the probability that this is a chance difference is less than 0.001.

TABLE 2
INCIDENCE OF *Proteus* agglutinin IN PATIENT'S SERA

General group	No. cases	Cases agglutinated	Agglutinated (%)	Cases not agglutinated	Not agglutinated (%)
I. Noncancer	163	130	80	33	20
II. History of cancer (treated)	24	20	83	4	17
1 No evidence recurrence	14	12	86	2	14
2 Recurrence	10	8	80	2	20
III. Active cancer (no treatment)	28	8	28	20	72

Group II has a history of cancer and has undergone such treatment as radical surgery, x-ray, and Coley's vaccine. Some show no evidence of recurrence after as long a period as 18 years, and others have extensive metastases so destructive that 2 have since succumbed to their disease. As a group, however, the treated cancer cases show an 86% agglutination with *Proteus* and present a picture similar to the noncancer patients.

With a view to reducing our percentage of error, we grouped, according to diagnosis, all noncancer cases that failed to show agglutination with *Proteus*. We have totaled and listed each group, tabulating them against a similar grouping of noncancer agglutinators (our false negatives against our correct positives).

TABLE 3
INCIDENCE OF *Proteus* agglutinin-SERA OF VARIOUS GROUPS WITH NO APPARENT MALIGNANCY

Diagnosis	Cases not agglutinated	Cases agglutinated	Cases not agglutinated (%)
Cervical erosion	4	15	21
T.B.	3	6	33
Benign growths	4	11	26
Psychiatric patients with no physical disease	5	16	23
Patients with no apparent disease	4	23	14
Miscellaneous	13	59	18

From Table 3 one can see that no particular disease has weighted the over-all error, nor can any pattern of false-negative reaction be established from the facts presented. When the chi-square method was applied to these differences in percentage not agglutinated among the several diagnoses, the variations were

shown to be insignificant statistically, with $P > 0.52$.

For some time now, the *Proteus* OX19 vaccine has been used diagnostically for typhus in the Weil-Felix test, which was designed to give a positive reaction with the sera of patients having a high titer of agglutinin. The so-called febrile antigen used in this reaction is not particularly sensitive, and dilutions of serum of 1:25, 1:50, or higher are required, as well as a limited testing time of only a few minutes (2).

More recently, Barnes (3) has used *Proteus* with a slide technique and reported that 73.9% of pregnant and 41.5% of nonpregnant women agglutinated the commercial antigen *Proteus* OX19. Our technique showed agglutination in a very high percentage of all normal adults, as indicated in Table 1, but these findings may be attributed to the time element involved, as well as to our particular antigen.

To contrast our preparation with the commercial product we titrated both against immune rabbit sera. For this purpose, rabbits were immunized 2 months before the test with intravenous injections of heat-killed *Proteus* organisms. We could then determine that the commercial antigen was agglutinated by immune sera that were in a dilution of only 1:10, whereas a dilution of 1:100 or more was sufficient to agglutinate our antigen.

Our findings, which indicate a lessened incidence of *Proteus* agglutinin in patients with an untreated malignancy, find support from several authors (4-7), who report a paucity of antibacterial antibody, as well as an associated impairment of the immunological response in both Hodgkin's disease and leukemia. Included in these studies of antibody and immunity were *Br. abortus*, *S. typhosa*, *S. paratyphi*, *S. schottmülleri*, *T. pallidum*, *B. tuberculosis*, and *Proteus* OX19.

It was of further interest to find a report (8) of two cases, one with lymphoid leukemia, where an intravenous administration of horse serum failed to raise the heterophile antibody titer, and the other with a probable leukosarcoma where the horse serum effected a minimal increase of sheep cell agglutinins.

Although our study has indicated an infrequent occurrence of *Proteus* agglutinin among untreated cancer cases, patients who have received therapy for their malignancy do not demonstrate a similar decline. This finding would seem to suggest some restoration of the immunological mechanism.

Since we have recovered *Proteus* agglutinin in the globulin fraction, the described variation in antibody titer may reflect a change in serum globulin under neoplastic conditions.

References

1. PARFENTJEV, I. A., and DURAN-REYNALS, F. (In press.)
2. KOLMER, J. A., and BOERNER, F. *Approved Laboratory Technique* (4th ed.) New York: Appleton-Century, 639 (1945).
3. BARNES, A. C. *Am. J. Clin. Path.*, **18**, 635 (1948).
4. DUBIN, I. N. *Ann. Internal Med.*, **27**, 898 (1947).
5. WALLHAUSER, A. *Arch. Path.*, **16**, 522, 372 (1933).
6. HOWELL, K. M. *Arch. Internal Med.*, **26**, 706 (1920).
7. ROTKY, H. *Zentr. inn. Med.*, **35**, 953 (1914).
8. GOLDMAN, R., FISHKIN, B. G., PETERSON, E. T. *J. Lab. Clin. Med.*, **35**, 681 (1950).

The Use of Positron-Emitting Radioisotopes for the Localization of Brain Tumors¹

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The preoperative detection and localization of intracranial neoplasms with radioactive isotopes from without the intact skull show promise of becoming an integral part of the neurosurgeon's armamentarium. In general, the technique is dependent upon the detection of relatively greater concentrations of isotope in neoplastic tissue as compared to that noted or found in normal structures. This, in turn, is dependent upon some biological property of the lesion which will favor concentration of the isotope or its carrier compound in the lesion, and upon the ability of a detection device to delimit differences in isotope concentrations in normal and in pathological areas. Up to the present, the isotope employed preoperatively has been the predominantly γ -emitting I^{131} contained in the dye diiodofluorescein (1-6).

To accurately locate a point source, or delimit an extended source, the system employed must be capable of sharply resolving the limits of the area of isotope concentration with reference to a suitable coordinate system. This requires that either the radioactivity or the detector be directional, and if the source is situated in a mass such as the human brain, scattering must be minimized.

Earlier workers have employed Geiger-Mueller counters as detectors, with suitable lead shielding to give directional collimation and protection from back-scattered radiation. Such shielding effectively combines with the inherently low γ -ray detection efficiency of the Geiger-Mueller tube to lower counting rates materially.

The application of the recently developed scintillation counters should partially obviate the problem of low counting rates (7-10). These devices offer high detection efficiencies in a small volume. Crystal efficiencies of from 10% to a theoretical 100% may be obtained, depending on the total γ -ray cross section of the crystal, which, in turn, is a function of crystal thickness and the energy of the radiation being detected. At a given efficiency, counting rates are dependent upon the area of the effective counting surface of the crystal and the size of the pulse from the detector accepted for counting (the operating bias). With proper care, perfectly linear systems, in terms of pulse energy, can be constructed, thus enabling one to select for counting only those pulses of greater than a given energy. In principle, this should make possible the elimination of the more widely scattered radiation and effectively augment shielding.

In surveying the above facts, which obtain for single directional γ -ray detection systems, it seemed that an additional method of delimiting areas of concentrated radioactivity from without the intact skull might be possible. It is known that the 2 γ -quanta resulting from positron annihilation emerge simultaneously and oppositely directed, with a precision of 1/137 radian (11). From a consideration of this angular correlation, it appeared that if one were to count these 2 γ -rays in coincidence, the source of activity must then lie somewhere on a straight line joining the 2 counters. In the absence of scattering, no lead collimator should be required, since the directional characteristic of the system is inherent in the radiation itself and independent of the detector.

Accordingly, we have tested this hypothesis, and have performed the experiments to be described in order to compare the geometrical resolution so obtained with that using single directional γ -ray techniques.

We have constructed scintillation counters designed to operate singly or for coincidence counting of oppositely directed annihilation quanta. In the detector used in this work 1-in. crystals of thallium-activated sodium iodide yield light pulses which are amplified by RCA-5819 photomultiplier tubes. The pulses are then fed to the X- and Y-axis amplifiers of a commercial oscilloscope operated without a sweep. The amplifier gains are set equal by viewing their output on a synchroscope. Pulses arriving simultaneously appear on the oscilloscope screen as an oblique deflection. An L-shaped shield obliterates the vertical and horizontal pulses present, and, by adjusting the oblique pulse origin a minimum acceptable pulse size may be selected. The oblique screen deflection is used to trigger a 931-A photomultiplier, which, in turn, drives a standard scaling circuit without further amplification. All high voltage is furnished by the power supply of the scaler. Complete details of the apparatus and experiments will appear elsewhere.

The performance of this apparatus as a single directional γ -ray detector was tested. Point sources of radioactivity of strength suitable for convenient counting rates were prepared. Data were obtained in air and in a fixed brain contained in a bare skull. Results are shown in Fig. 1.

Curve A (Fig. 1) represents results obtained with a Zn^{65} ($E_{\gamma}=1.12$ mev) source suspended in air 9 in. away from the center of the crystal, and with only the lead collimator number 1 of C (Fig. 1) in place. This collimator is a tapered cone of 3-in. maximum diameter, with a 1-in. square opening aligned with the 1-in. square crystal. The shape of the counting rate curve to be expected from this arrangement in the absence of scattering is depicted in C (Fig. 1). In position 1 the source "sees" all of the crystal, in position 2 it "sees" a portion, and in position 3 it "sees" none of the crystal. The width of the curve can never be less than the width of the collimating slit, a situation analogous to the umbral and penumbral shadows cast by a sheet with a square hole. The minimum pulse

¹This work was done under contract AT(40-1)-289 between Duke University and the Atomic Energy Commission.

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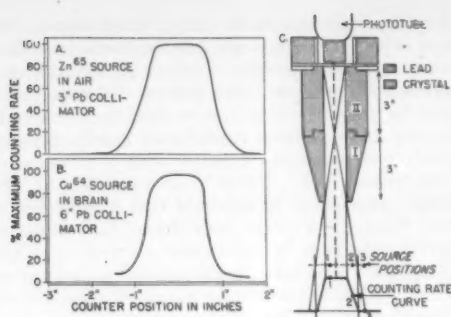


FIG. 1.

size accepted for counting was $\frac{1}{4}$ the size of the maximal pulse sizes present. Curve A (Fig. 1) may be seen to closely resemble the theoretical curve of C (Fig. 1).

Curve B (Fig. 1) reflects data obtained with a Cu^{64} source buried $1\frac{1}{2}$ in. deep and $\frac{1}{2}$ in. from the midline in the left occipital cortex of a fixed brain contained in its skull. Lead collimators I and II (of C, Fig. 1) were used. The center of the crystal was 7 in. away from the skull and approximately $9\frac{1}{2}$ in. from the source. The decay scheme of Cu^{64} is said to be 54% K capture, 31% β -emission (0.571 mev), 15% positron emission (0.657 mev). A 1.35-mev γ -ray is mixed with the K capture radiation to the extent of 1.5% (12). Since the path of the positron is of the order of millimeters, in the matter used here, a strong point source of extranuclear γ -radiation resulted from the annihilation quanta. For this experiment the minimum acceptable pulse size was set at $\frac{1}{4}$ the size of

the maximum annihilation pulses. With the exception of a persistent counting rate above room background at the ends of the curve, it may be seen that the shape of Curve B (Fig. 1) closely resembles Curve A (Fig. 1). This persistent elevation is thought due to scattering in the head. Counting rates obtained under the above conditions were increased by a factor of better than 47 over those obtainable with a shielded Geiger tube under the same conditions. Here again the width of the counting rate curve is commensurate with the effective crystal counting area. To decrease this width necessitates a sacrifice in counting rates.

Data obtained by coincidence scintillation counting of annihilation pairs are shown in Fig. 2. Point sources of Cu^{64} were suspended in air or placed in fixed brain between directly opposing counters. Only those pulses greater than $\frac{1}{4}$ the maximum annihilation quanta pulse size were accepted for counting. Source strengths were suitable to give convenient counting rates.

Curve A (Fig. 2) was obtained with the Cu^{64} source suspended in air and encased in such a way that the positron ranges were short enough to enable consideration of the whole as a point annihilation quanta source. No collimator was used. It is obvious that the width of this curve is much smaller than the width of either of the curves of Fig. 1. Inspection of E (Fig. 2) reveals the reason. Consider those γ -rays which happen to strike the upper crystal in this diagram. With the source in position 1, the corresponding simultaneous and oppositely directed rays are confined to 1-1 and cannot strike the lower crystal. Thus, in the absence of scattering, no coincident counts will be recorded. With the source in position 2, some of the corresponding rays strike the lower crystals. With the source in position 3, all the corresponding rays strike and the coincidence counting rate is maximum. With a rectangularly shaped crystal, the counting rate should rise linearly in the region of which position 2 is typical, yielding a triangularly shaped curve. Curve A is a reasonable approximation of this expected shape.

The directional property of the radiation itself allows an approach to the problem of radiation widely scattered in the head. If 2 parallel lead collimators are employed, those scattered rays which deviate from parallelism will be unable to traverse the collimators and strike the crystals.

Using 6-in. lead collimators and the same Cu^{64} source located in fixed brain as described above, the counting rate data presented in B (Fig. 2) were obtained. Beyond the limits of the slit the rate rapidly approaches zero. The widening extending some $\frac{2}{3}$ of the way up the curve is probably due to small-angle scattering from the collimator. Thus, it would appear that scattering can be practically eliminated.

With the collimators removed, Curve C (Fig. 2) was obtained. It may be seen that the effect of scattering is to slightly widen the curve and to give persistent background counts at both ends of the curve.

Curve D (Fig. 2) was obtained without collimators

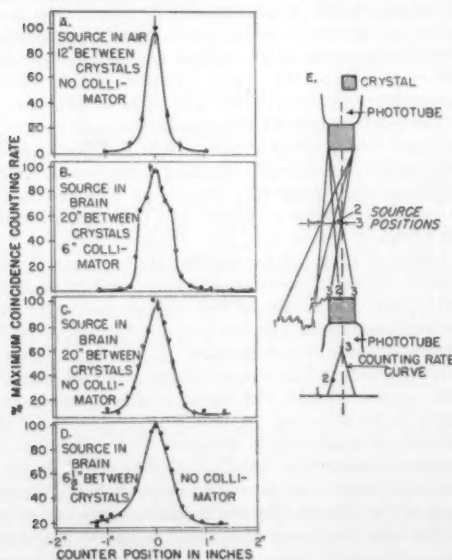


FIG. 2.

TABLE 1

Method	Shield used	Relative peak counting rate
Geiger tube $9\frac{1}{2}$ " from source	Shield and 6" collimator with 1" slit	1
Coincident scintillation counters, $6\frac{1}{2}$ " crystal-to-crystal distance	None	23
Single directional scintillation counter $9\frac{1}{2}$ " from source	6" collimator with 1" slit	47

and with the counters adjacent to the skull. It will be noted that the scattered counting rate increases more rapidly than the maximum coincidence counting rate. Spurious coincidences due to scattering are dependent upon the inverse square law, and the probability of their occurrence is greatest near the skull.

Maximum counting rates in the various experimental arrangements are in the approximate ratios shown in Table 1. With coincident scintillation counters and a 20-in. crystal-to-crystal distance, the rates were correspondingly lower than the $6\frac{1}{2}$ -in. crystal-to-crystal distance. Throughout this work, room background coincident counts were negligible, amounting to 0.11 cpm over a 72-hr period.

In coincidence work the counting rate is proportional to the square of the detection efficiency of the detectors used. The high detection efficiency offered by scintillation counters makes the counting rate loss in such work less serious than with Geiger tubes, where perhaps a hundredfold loss may be expected. Furthermore, with proper attention to the detection efficiency, and by operating close to the head, it is theoretically probable that a coincidence system could be made to yield counting rates comparable to those of the single directional γ -detection system.

Thus, it appears possible to more accurately delimit point sources and, hence, extended sources with the technique of coincidence counting of annihilation pairs. The width of the counting rate curve is again the width of the counter, but the sharp peaks are independent of counter size. Since scattering does not appear serious, and can be almost entirely eliminated, only the purely geometric factors of application of the counting rate curves to a suitable coordinate system would seem necessary to localize a radioactive source within the skull.

The Cu^{64} used in the work described is a readily available positron emitter.³ To concentrate this isotope in a brain lesion the following facts were considered. Friedemann (13) has summarized the work

³ Obtainable from Oak Ridge National Laboratories, Oak Ridge, Tenn.

leading to the principle that the blood vessels of the central nervous system are normally impermeable to anionic or negatively charged dyes or particles. If the tissue structure is altered, penetration of such agents into the altered areas may occur. In addition, Figge has reported the apparent affinity of certain carcinomata for the porphyrins (14). There is also some possibility of a specific affinity of brain lesions for organic dyes.

As a starting point in the localization of positron-emitting isotopes in brain lesions, preliminary studies, to be reported in detail elsewhere, have been performed with the anionic dye tetrasulfonated copper phthalocyanine (tetra-benzo-tetra-aza porphyrin).⁴

A simple method for the synthesis of Cu^{64} phthalocyanine has been developed. The preparation of sterile solutions of desired concentration can be accomplished in 2-3 hr, starting with metallic copper.

Doses up to 100 mg/kg have been given to a large number of rabbits, mice, guinea pigs, cats, and dogs, with apparent impunity.

The distribution and excretion of the injected dye have been followed in adult rabbits. Although the biological half-life exceeds the 12.8-hr physical half-life of the Cu^{64} , after 2 days only 6% of the injected radioactivity remains to injure tissue. The major route of excretion is via the biliary system.

Copper phthalocyanine will penetrate only those areas of the brain in which the tissue structure has been altered. Brain injury was experimentally produced in rabbits, mice, and cats by the intracarotid injection of radiopaque contrast media, needle punctures, and thermal coagulation (14, 15). Administration of the dye produced focal uptake in the damaged areas. Experimental tumors growing subcutaneously and intracranially in mice have been found to take up the dye in amounts considerably greater than the surrounding normal tissues.

References

1. MOORE, G. E. *Science*, **107**, 569 (1948).
2. BOYACK, J., MOORE, G. E., and CLAUSEN, D. F. *Nucleonics*, **3**, 62 (1948).
3. MARVIN, J. F., and MOORE, G. C. *Ibid.*, 63.
4. MOORE, G. E., PEYTON, A., and FRENCH, L. *J. Neurosurg.*, **5**, 392 (1948).
5. MOORE, G. E., et al. *Radiology*, **55**, 344 (1950).
6. ASHKENASY, M. *J. Lab. Clin. Med.*, **34**, 1580 (1949).
7. HOFSTADTER, R. *Phys. Rev.*, **75**, 796 (1949).
8. JORDAN, W. H., and BELL, P. R. *Nucleonics*, **5**, 30 (1949).
9. MCINTIRE, J. A., and HOFSTADTER, R. *Phys. Rev.*, **78**, 617 (1950).
10. BELL, P. R. *Science*, **112**, 7 (1950).
11. DE BENEDETTI, S., et al. *Phys. Rev.*, **77**, 205 (1950).
12. SEABORG, G. T., and PERLMAN, I. *Rev. Modern Phys.*, **20**, 585 (1948).
13. FRIEDEMANN, W. J. *Physiol. Revs.*, **23**, 125 (1942).
14. FIGGE, F. E. J., and WEILAND, G. S. *Abstr. in Cancer Research*, **9**, 549 (1949).
15. BROMAN, T., and LINBERG-BROMAN, A. M. *Acta Physiol. Scand.*, **10**, 102 (1945).
16. MACKLIN, C. C., and MACKLIN, M. T. *Arch. Neurol. Psychiat.*, **3**, 153 (1920).

⁴ Suggested by Lester H. Corrain, Molecular Spectroscopy Section, Department of Physics, Duke University.

Comments and Communications

On Structural Variation in Conifer Wood

WE HAVE noticed with great interest the comment of R. D. Preston (*Science*, 112, 312 [1950]) about our note on x-ray investigation of the change in orientation of cellulose in sound and infected tracheids of chir (*Science*, 111, 151 [1950]). Regarding his contention that we have not referred to his work in our note, we have to say that as his brilliant work is not directly related to our discussions we avoided referring to it in our short preliminary note; we shall refer to it in detail in our complete paper. The extreme variability of structure in conifer wood, as pointed out by him, was also mentioned in our note and therefore received our very special attention. Contiguous chips from a region in the block of the sample which looked quite homogeneous have been used in the experiment, one chip being taken for an x-ray photograph of the sound wood, and another to obtain the photograph of the infected sample. As we obtained the same result on repeating the experiment a number of times, the results cannot be spurious. We are, however, attempting to take x-ray photographs of the same sample before and after infection, but as the samples for x-ray photographs are quite thin it is difficult to avoid complete disintegration of the sample on infection.

Dr. Preston's suggestion that the observed results are due to the removal of a disordered fraction of cellulose as a result of selective enzymatic action on disordered cellulose only appears to be too premature. Attempts are being made to bring out the mechanism that produces this interesting result.

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The Earth's Origin

HAROLD C. UREY (*Science*, 110, 445 [1949]) has suggested that the core of the earth was composed of "moon-like material" surrounded subsequently by a uniform mixture of stone and iron. Later this core rose to form the Pacific Basin. The composition of Earth, Venus, and Mars can be explained by chemical reactions occurring at temperatures of 1,500–1,600° A. In a personal communication Dr. Urey wrote that he believes the earth is becoming 1,000 degrees hotter per billion years, and that the solar system condensed from cold gas and dust. Some of the difficulties inherent in this hypothesis are:

a) When the original core of the earth was gathering its mantle of stone and iron, the moon, revolving around the earth, should also have acquired a similar mantle.

b) The terrestrial rarity of neon requires that the earth condensed from dust and gas, in which the concentration of this cosmically abundant element was vanishingly small, for neon could not have escaped capture unless the temperature had been from 5,000 to 8,000° A.

c) If, as Urey suggests, condensation occurred at temperatures of 1,500–1,600° A, the anhydrous atmosphere would necessitate the assumption that Mars condensed in an anhydrous region of space, for water could not have been thermally dissipated from Mars at the temperatures postulated by Urey.

d) The formation of the Pacific Basin as postulated by Urey requires that the original core, which he assumes to have been of "moon-like material," should rise to the surface as a whole in order to form "the Pacific Basin with its floor of basaltic rock." Even if the earth had an original core of rock, it could scarcely have bobbed up in one piece, for the tensile strength of rock, especially if hot, seems inadequate to permit the leading hemisphere to pull the following hemisphere downward past the center of the earth. Instead, the buoyancy of the core would have pulled it apart into many fragments, thus forming, not one Pacific Basin, but many basins with "basaltic floors" scattered over the face of the globe.

e) The expansion of the earth in becoming 1,000 degrees hotter would be expected to cause tension failure all over the earth, but nearly all the failures are due to compression.

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Undergraduate Chemical Research

TO THE average freshman on registration day, research and chemistry are synonymous, but in too many schools the chemistry major graduates without ever having experienced anything but regimented laboratory exercises, repeating classic experiments that he can find described in dozens of textbooks. Of course, such exercises are vital preliminaries to research, but they are not very stimulating to the chemistry majors we would like to encourage to go on to graduate school.

Some schools have tried to remedy the situation by assigning senior research problems, but commonly we lose our best students to mathematics or physics in their sophomore and junior years. Besides, a senior problem is often merely busy work, because its selection is limited by what is assumed to be undergraduate research ability and by what is available in the way of faculty supervision, laboratory space, credit hours, equipment, and chemicals. As a consequence, the average senior problem is not of sufficient importance to merit a paper and probably will not be published, even anonymously, in the proper tables of such data.

Yet each one of us has repeatedly searched the literature in vain for some simple constant that he knows one of his good juniors could determine if he only had the time. It is even probable that the par-

ticular constant wanted has been determined many times over because it was necessary to some larger research problem, but it has not been published or collected for the proper table of data.

Some of us have tried to encourage our seniors by assigning a problem to a team of students in the hope that, in the short time allotted, enough work will be done and enough checks made to publish the results. But almost invariably the whole project fails because one student fails to complete his share.

Many solutions to the problem of stimulating undergraduate research had been suggested and tried, including the idea of cooperative research, when a national cooperative research program was proposed by W. P. Cortelyou and the author of this paper in an article in the December 1936 *Journal of Chemical Education*.

Ultimately, the National Cooperative Undergraduate Chemical Research Program was organized at the St. Louis meeting of the American Chemical Society on September 6, 1948, to stimulate undergraduate chemical research and to supply data to fill existing gaps in the chemical literature. The major premise of the program is that usable chemical data can be obtained from check results made by two or more undergraduate students assigned to a specific determination, independent of, and unknown to, each other.

As the program is only a little more than two years old, our organization is still in the experimental stage. Our new catalogue has been mailed to about 100 schools. It lists 8 research projects that have been set up for cooperative research:

1. Sensitivity of inorganic qualitative analysis reagent solutions, directed by W. P. Cortelyou, of Roosevelt College.
2. Solubilities of inorganic fluoride salts in organic solvents, directed by John H. Walkup, of Centre College.
3. Solubilities of inorganic chloride salts in organic solvents, directed by Kirby E. Jackson, of the University of Alabama.
4. Solubilities of the inorganic sulfamates in water at various temperatures, directed by Sister Agnes Ann, of Immaculate Heart College.
5. Preparation and characterization of acyl derivatives of acenaphthene, directed by Edith J. H. Chu, of Immaculate Heart College.
6. Preparation and characterization of alkyl esters of benzenesulfonic acid, directed by Bertin L. Emling, of St. Vincent College.
7. Determination of indices of refraction of two-liquid solutions at different concentrations of each liquid, directed by R. I. Rush, of Centre College.
8. Determination of vapor pressure relations of organic compounds, directed by Elton M. Baker, of Fresno State College.

Each project is in a field of research where the techniques are within the abilities of undergraduates and in which the results will be of more than academic interest. Each project director expects to collect enough data to publish one or more papers, and adequately checked data will be sent to N. A. Lange to be published in the proper tables of the *Handbook*

of Chemistry. The program is financed by contributions of \$10 a year from each school sponsoring one or more projects.

Each project is subdivided into research units. A research unit is of such a nature that a student can obtain acceptable results and write a complete research report in 50 laboratory hours, the equivalent of one semester hour of college credit. For instance, a research unit of Sister Agnes Ann's project on the solubilities of inorganic sulfamates is the determination of the solubilities of calcium, barium, and strontium sulfamates in water at 20°, 30°, and 40° C.

The project director assigns each research unit to two or more students in different schools and furnishes adequate laboratory procedures. The research of each cooperating student is directed by his own teacher in his own laboratory. When the student has completed a research unit his teacher, the local director, sends his report to the project director. When a report is accepted the project director recommends that the successful student be awarded a Certificate of Acceptance by Handbook Publishers, Inc. (publishers of the *Handbook of Chemistry*).

Certificates have been awarded to 12 students cooperating on Dr. Cortelyou's project on the sensitivity of qualitative analysis reagents and to 2 students cooperating on Rev. Bertin Emling's project on the alkyl esters of benzenesulfonic acid. Both men expect to publish papers soon. Of course, each paper will list the names, teachers, and schools of the students furnishing the data used.

The program has thus already started "to stimulate undergraduate research and to supply data to fill existing gaps in the chemical literature." In addition, several logical by-products can be expected. Under this program a teacher in even a very small school may direct a research project and have enough student participants to obtain publishable results. If the program develops normally, any university might recognize a Certificate of Acceptance as a qualification for a graduate fellowship or assistantship. It has even been suggested that universities might sponsor projects in the program in much the same way that the major league baseball teams sponsor bush league teams to train potential Joe DiMaggios. Indeed, the program might be beneficial to a university's own undergraduate chemistry majors, who are often neglected because the best of the faculty, laboratory space, and equipment are reserved for graduate research.

Industry might profit by, and collaborate in, this work. When, as in the May 1950 *Journal of Chemical Education*, a list of cooperative research projects is published, individuals or companies having pertinent data in their files could submit it to the project directors to be checked by independent workers. This would help eliminate much needless repetition and result in the publication of a tremendous mass of hitherto unavailable data.

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A Simple Method of Microradiography Using Ordinary Diagnostic X-Ray Equipment

THE purpose of this paper is to present a preliminary report on a simple method of microradiography. Several authors (1-4) have described techniques for microradiography, using either a diffraction unit with low voltage or photoelectrons. In our method rabbits were injected with a radioopaque substance (10% silver iodide, with 3% acacia added) *in vivo*, and the kidney was removed and fixed in formalin. Sections of 300 μ thickness were then cut. The apparatus used to produce the microradiograph was an ordinary diagnostic x-ray machine with a rotating anode tube. In order to prevent as much of the vibration from the rotating anode as possible, the end of

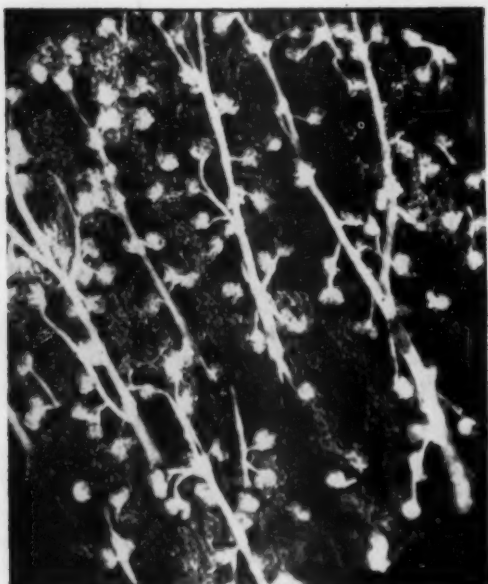


FIG. 1. Rabbit kidney. Factors: 30 kv, 100 ma, 4% in. target film distance, 40 sec exposure, rotating anode tube ($\times 25$).

the tube arm was braced by resting it on a cone placed on the table, the specimen was placed between two layers of Stryafoil (obtainable from B. X. Plastics, London, Eng.) and fastened to the glass plate (Kodak 548-0 spectroscopic plate) by tape at the periphery; the plate was then taped securely to the window of the tube. (The tube in our apparatus has a window opaque to light.) This eliminated independent motion of either tube or photographic plate. The factors used were 30-70 kv, 100 ma, 4-40 sec exposure. The plate was developed in Kodak D 19 developer. Examples of microradiographs produced by this method are shown in Figs. 1-3. The difference in density between the opaque medium in the smaller capillaries of the kidney

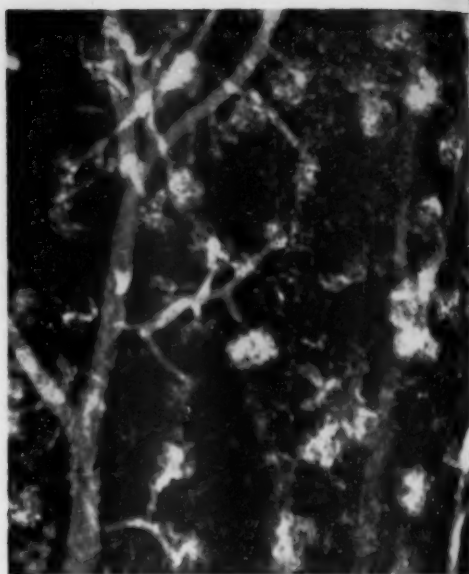


FIG. 2. Same as Fig. 1 ($\times 75$).

and the surrounding tissue apparently is sufficient to allow clear differentiation of the vessels by this new method. Lack of independent motion of the film or tube prevented diminution of sharpness of detail on the microradiograph.

This preliminary report describes an extremely

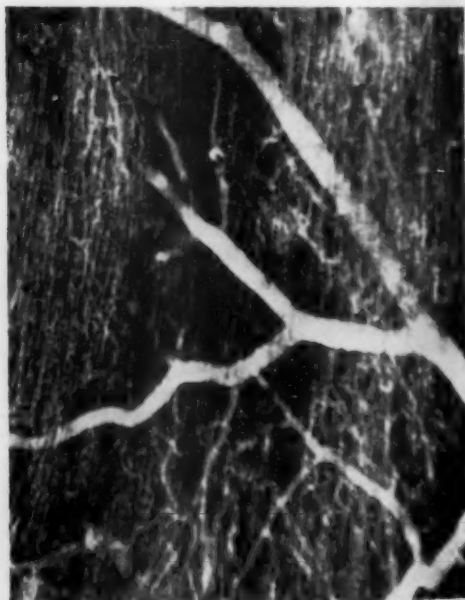


FIG. 3. Rabbit myocardium. Same factors as Fig. 1 ($\times 75$).

simple method of microradiography, which requires no special equipment other than any of the ordinary diagnostic units, and produces microradiographs that give good detail of the smallest capillaries. It is of value in microradiography when opaque substances are used for contrast, and enlargements of good quality can be made up to 75 times.

References

1. LAMARQUE, P. *Brit. J. Radiology*, **11**, 425 (1938).
2. BOHATIRCHUK, F. *Acta Radiology*, **25**, 351 (1944).
3. BARCLAY, A. E. *Am. J. Roentgenol. Radium Therapy*, **60**, 1 (1948).
4. TRILLAT, J.-J. *J. Applied Phys.*, **19**, 844 (1948).

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Stimulation of Growth of *Phytophthora citrophthora* by a Gas Produced by *Mucor spinosus*

THE contamination of a large Petri dish containing several thalli of *Phytophthora citrophthora* (Sm. and Sm.) Leonian, by *Mucor spinosus* van Tieghem¹ showed that the presence of the contaminant had stimulated the growth in diameter of *P. citrophthora*, as compared with uncontaminated dishes. The approximately equal diameter of all the thalli in the contaminated dish pointed to the action of a gas rather than to a substance produced by the culture of *M. spinosus* diffusing in the medium.

Several experiments were performed, of which only two will be described here. Seven 10-cm dishes containing potato dextrose agar medium inoculated with *M. spinosus* were placed in a 9-liter sealed desiccator. Twenty-four hr later 5 dishes containing water-agar medium, inoculated at four places with *P. citrophthora*, were placed in a similar desiccator connected with the other by means of rubber tubing, the connection, however, being closed while the air was withdrawn from the desiccator containing *P. citrophthora* until the pressure reached 3 cm of mercury. The suction pump was disconnected, and the two desiccators were connected with each other. After pressure was equalized, air was admitted so as to restore normal atmospheric pressure. The operation was repeated morning and evening for 3 consecutive days. As a control, an equal number of Petri dishes containing *P. citrophthora* had been placed in a similar desiccator connected twice a day to another desiccator containing 7 dishes with noninoculated potato dextrose agar medium. The mean diameter of 20 thalli was, respectively, 29.83 mm for the cultures submitted to the action of the gas, and 17.86 mm for the controls (minimum significant difference, 1% level: 1.26 mm).

In another experiment one 9-liter desiccator received 7 dishes containing 9-day-old cultures of *M. spinosus* on potato-dextrose agar. After 24 hr it was connected

to a vacuum pump through a gas-washing bottle containing 150 ml of twice-distilled water until the pressure was reduced to 30 cm of mercury. A 2% water-agar medium was prepared, sterilized in sealed flasks, and poured into 6 Petri dishes. Checks were provided by using the same method with nontreated, twice-distilled water. Each dish was inoculated with *P. citrophthora* at 4 points. After 4 days the mean diameter of 24 thalli was, respectively, 21.7 mm for the cultures grown on the medium prepared with water bubbled with the gas from *M. spinosus* and 18.04 mm for the controls (minimum significant difference, 1% level: 1.85 mm).

The same results were obtained in experiments using Czapek agar medium instead of water-agar, but with smaller differences as compared with the controls.

It is thus apparent that *M. spinosus* produces a gas which greatly stimulates the growth of *P. citrophthora*. This gas is probably not ethylene. Petri dishes containing cultures of *M. spinosus* were placed under bell jars together with young tomato plants. No indication of epinasty of the leaves was observed. The elongation of 3-mm sections of *Avena* coleoptyles was not influenced by the presence in the same jars of cultures of *M. spinosus*. Other experiments are being carried out to ascertain the nature of the gas produced by *M. spinosus*, its influence on other microorganisms, and its production by other plants. The complete paper will be published in *Arquivos do Instituto Biologico*.

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Cold-Region Plants

IN THE paper by Arnold and Libby (*Science*, **113**, 111 [1951]) on radiocarbon dates, it is stated that sample #406, charcoal, taken from the Lascaux Cave in the Dordogne is "... of conifer *Abies* or *Larix*, neither of which grows in cold climate." Unless it is considered that the cold climate of 15,000 years ago was different from what we consider cold today, it would be better to say "both of which grow in cold climate." *Abies* species inhabit cool and relatively cold regions, and do not flourish in regions where summers are hot. *Larix* is a genus of essentially cold-region plants, some species being noted for the fact that they form the northernmost forests in the world. They are reported north to 67° in North America and to 72° in Siberia—i.e., north of the Arctic Circle. The name *sibirica* applied to a species in each of these genera is indicative of their range. Both larches and firs extend even now, however, into the middle latitudes of the Northern Hemisphere, particularly at higher elevations.

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¹ Identification of *M. spinosus* was supplied by the Centraalbureau voor Schimmcultures, Baarn, Holland.

Economy of Symbols

THE following observations may contain suggestions useful to research workers or others who would like to find systems of classification and/or enumeration requiring as small a number of symbols as possible.

1. The number of weeks in the year, 52, is exactly double the number of letters in the English alphabet. By choosing capital or lower-case letters we can denote in one symbol any week in the year. If we let *A* represent the first week in January, *a* the second week, *B* the third, and so on, the actual error possible through a confusion of caps with lower case becomes certainly small and probably negligible. For example, the birth date of an animal, *f5l*, would signify the week of March 19, 1951. In many instances merely *f1* would serve, where Mar 19 '51, with five unnecessary symbols, has been commonly in use.

2. Using only two letters of the alphabet permits us to give identity and ordinate rank to 702 different objects and yet do so with only two symbols. If one or two numbers are used, the limit is 110. With one, two, or three letters of the alphabet, 18,278 different objects can be denoted, as contrasted with 1,110 if one to three numbers are used. The economy becomes impressive when four letters are used—475,254 items, as compared with 11,110 when every combination of four numbers is employed.

3. Employing all the letters of the alphabet except *Q*, and also all the digits except 1 and 0 (because they are so easily confused with the letters *l* and *o*), we have 33 entirely familiar symbols that permit giving identity and ordinate rank to 1,122 different objects (cf. 702 in ¶ 2) by means of only one or two letters and numbers.

4. Omitting *Q*, we have in the English alphabet 20 consonants and 5 vowels. Using a consonant and a vowel, we can denominate 100 objects, either in 5 or less general categories of up to 20 subclasses each (*AB, AC, AD . . . ; EB, EC, etc.*), or up to 20 categories with not more than 5 subclasses in each (*BA, BE, BI, BO, BU ; CA, etc.*).

Three or four consonant-vowel combinations can be combined as syllables into a uniformly pronounceable word, such as *SADOTO*, with *S* pronounced *SH* and *C* pronounced as *S* to avoid variant pronunciations of *C* that would be confused with *S* or *K*. There are 1,000,000 different combinations in this three-syllable and easily pronounceable combination. Such a symbol is shorter to speak than, for example, "seven hundred and nineteen thousand two hundred and forty-two," or even "seven one nine two four two." With two such three-syllable names, every human being in the world for at least the past hundred years could have had a distinctive and pronounceable name. But the use of syllables to convey classifications and categories provides more interesting possibilities.

As an example, let us assume that to classify drafts the following information is pertinent and the number of categories is appropriate:

1. Year of birth: 100 categories, beginning 1900 as *AB*, 1901 *AC*, 1919 *AZ*, 1920 *EB*, and so on; e.g., *EH*.
2. State, territory, or subdivision where draft records are kept: Up to 100 categories, by means of two letters; e.g., *OS*.
3. Month of the present classification: 100 categories, covering an 8-year period; e.g., *IP*.
4. Single, married, children, etc.: 5 categories, using one vowel each; e.g., *A*.
5. Training or skill: 500 categories, using three letters; e.g., *DEV*.
6. Experience or stage of training: 5 categories, using one vowel each; e.g., *O*.
7. Months of military service to date: 100 categories, using two letters each; e.g., *DU*.
8. Any other rating: Up to 20 categories, by means of one final consonant; e.g., *R*.

Splitting the above sequence of letters up into two convenient words, we have: *EHOSIPA DEVODUR*.

The information conveyed by *EHOSIPA DEVODUR* according to the above classificatory designations is: Born in 1925, draft record in Kansas office, this classification made in May 1951, single, medical training, graduate and in intern stage of training, has already had 13 months of military service—the final consonant being available for any other desirable classification, such as branch of service, priority rating, etc.

These classificatory words differ in number of syllables. The first begins and ends with vowels, the second begins and ends with consonants. The words are therefore not easy to confuse with each other. Reference to a whole category of persons born in, say, 1925 could be made thus: *EH---*; or to all those with 13 months of military training as *---DU-*. Statements relating to any whole category or categories can thus be made explicit and precise.

ALAN GREGG, M.D.

Determination of Carbonyl Groups by Reaction with Radioactive Cyanide, and a Simple Means for Estimation of Molecular Weight in Polysaccharides¹

POLYSACCHARIDE molecules have end groups of two kinds, corresponding to the beginning and ending of the polymer chain. In most polysaccharides, one end group consists of a reducing monosaccharide unit, and there is usually one, and only one such group in the molecule. The other kind of end group is found at the opposite end or ends of the molecule and is non-reducing. Attempts have been made to discover the average molecular weight by determination of the number of reducing end groups. The ratio of the reducing and nonreducing end groups has also been used to estimate the extent of branching in the molecule. Because of the relatively small number of reducing end groups, however, their accurate estimation in large molecules has been difficult.

The writer has found that the reducing end groups

¹ Aided by a grant from the Atomic Energy Commission.

of polysaccharides can be combined with C^{14} -labeled sodium cyanide to give a cyanhydrin that on saponification yields a radioactive carbohydrate containing one carbon more than the parent polysaccharide. The reaction, which is the well-known cyanhydrin synthesis, converts a 6-carbon reducing end group to a 7-carbon unit containing a radioactive carboxyl. The presence of the carboxyl permits the separation and purification of the material by means of ion exchange resins. Thus absorption of the carboxyl derivative on a basic resin separates it from any unreacted polysaccharide, and elution of the absorbed material with aqueous ammonia provides a highly purified radioactive product. On account of the high sensitivity of radioactivity measurements, the combining proportion of the radioactive cyanide can be determined accu-

rately. This is a measure of the average molecular weight of the reacting polysaccharide. The procedure provides not only a new tool for structural studies, but also a means for labeling carbohydrate material for biological and other investigations. Furthermore, it constitutes a sensitive method for ascertaining the number of carbonyl groups in a substance of known molecular weight. Reaction of polysaccharides with cold cyanide yields products that may have useful properties. The procedure is particularly suitable for the study of polysaccharides of relatively low molecular weight, and partially hydrolyzed products.

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Book Reviews

Crystal Growth. H. E. Buckley. New York: Wiley; London: Chapman & Hall, 1951. 571 pp. \$9.00.

Anyone faced with the necessity of growing "perfect" crystals of any considerable size should first read this book. He will find it a bit slow going here and there, partly because of the author's weakness for long sentences (the first sentence on page 7 consists of 90 words), and partly because of his liberal use of "former" and "latter." If the reader is not disturbed by this he will find he has a very useful reference book.

The 12 chapters range from "The Artificial Preparation of Crystals" and "Theories of Crystal Growth" through "Modification of Crystal Habit by Impurities" to "Relationship of Substances during Crystallization." The thoroughness with which the author has covered his topics may be judged by the fact that he lists over 650 references to the literature, coming from the publications of more than 475 authors. The book contains 169 figures and 88 plates, all of high quality.

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Problems of Cytology and Evolution in the Pteridophyta. I. Manton. New York: Cambridge Univ. Press, 1950. 316 pp. \$8.50.

Most recent books dealing with the synthetic approach to problems of evolution have discussed, primarily, general principles, with illustrations taken from various groups of animals and plants. These books have established certain principles and methods of attack on evolutionary problems, on which there is an ever-increasing amount of agreement. The logical sequel to these works is a series of many-sided attacks on problems of evolution in particular groups of animals and plants. One such attack is the volume by Dr. Manton on the Pteridophyta, and it is one which sets a very high standard.

Upon even a casual examination of the book, one is impressed by the amazing technique Dr. Manton has developed for studying the cytology of the Pteridophyta. Ferns and their allies have always been regarded as extremely difficult material for chromosomal studies. Their chromosome numbers are very high, and their somatic chromosomes are usually long, slender, and entangled among each other so that they are difficult to count. Furthermore, their cytoplasm often contains heavily staining inclusions, which tend to obscure the chromosomes. As a result, before Dr. Manton began her work, the numbers of few species were known with exactitude. But the present volume contains page after page of photographs and drawings of meiotic smear preparations in which gametic numbers which range from $n=13$ (in *Hymenophyllum tunbridgense*) to $n=108$ (in *Equisetum* spp.), and even $n=256$, recorded in *Ophioglossum vulgatum* as the highest chromosome number known for any living organism, can be counted by the reader either exactly or with a reasonable degree of accuracy. Dr. Manton's techniques, which would require much patience and experience to reproduce successfully, are nevertheless well described in an appendix, so that anyone who desires to and has sufficient skill may follow in her footsteps.

The text may also be commended for its readability. Dr. Manton has achieved a fine balance between scientific precision and a personal narrative style. While learning a multitude of hitherto unrecorded facts about the interrelationships among the fern species of northern Europe, the reader accompanies her on field trips to the native habitats of many of them, on explorations through the rich literature on their systematics and morphology, and in her contests with them as refractory cytological objects. For instance, she writes as follows about the well-known boreal and

high montane species of club moss, *Lycopodium selago*:

... here the cytologist's troubles reach a climax in spite of the ease of cultivation and other advantages which one might expect would facilitate the task. In actual fact this species is, in my experience, the worst cytological object that I have ever encountered, and in the unequal contest between cytologist and plant, the plant has in this case so far won handsomely.

Most of the material is from Dr. Manton's own researches of the past 20 years, here presented for the first time. Her most important results are as follows. Each genus of ferns is shown to have a single definite basic chromosome number, and in cases where more than one number is recorded for a genus, as in *Dryopteris*, good morphological evidence is presented for recognizing more than one genus—these generic segregations being in accord with the opinions of one or another well-known specialist in pteridophyte taxonomy. Cytology has thus provided good evidence for deciding many of the disputes between taxonomists as to the generic status of certain groups. Furthermore, similar chromosome numbers found in different genera often point the way toward a settlement of disputes concerning generic affinities. Thus *Polystichum* and *Dryopteris*, *sensu strictu*, both have the basic haploid number $x=41$, and show their relationship in various morphological features; whereas *Thelypteris*, which is united with *Dryopteris* by some authors, has $x=34$ and $x=35$, and so appears to be more distantly related, as one might suspect from its superficial appearance and habitat.

The basic numbers in the family Polypodiaceae range from a probable $x=29$ in *Pteris* and *Pellaea* to $x=52$ in *Pteridium*. In the Osmundaceae all genera have $x=22$, in the Hymenophyllaceae $x=13$ and $x=18$, and in the Ophioglossaceae $x=45$ and $x=ca. 128$. Among the other Pteridophyta, similar high basic numbers are recorded, except in *Isotetes*, with $x=10$, and *Selaginella*, with $x=9$. *Lycopodium* is the only genus with several rather different basic numbers, and on this basis Dr. Manton suggests that the British species of *Lycopodium* (p. 252) "... seem now to be far more different from each other than are the genera or even groups of genera of the Polypodiaceous ferns. This is perhaps a sign of antiquity."

Dr. Manton does not discuss directly the fact that immediately strikes anyone familiar with the cytology of the higher plants, namely, that the basic chromosome numbers of genera of Pteridophyta are much higher than those of Angiosperm genera. She suggests that aneuploid changes have resulted in increasing basic numbers, but an equally valid hypothesis is that the genera themselves are of ancient allopolyploid origin, and that the phylogeny of the various families is highly reticulate. If this were true, the great differences between the opinions of specialists on the phylogeny of the Pteridophyta would be made understandable, though not resolved.

Within nearly every genus Dr. Manton has recog-

nized polyploid series, often involving types that systematists have placed in the same species. In some instances she has produced clear evidence that species with higher numbers are allopolyploids, derived by hybridization and chromosome doubling from species with lower numbers, the identity of which she has determined. Furthermore, the polyploids of uncertain derivation nearly all have characteristics of allopolyploids, so that autopolyploidy appears to have played a negligible role in the evolution of the Pteridophyta. This part of Dr. Manton's work would have been much more meaningful if she had been able to study the species complexes throughout their entire range, rather than in Great Britain and northern Europe alone.

The problem of apogamy, both natural and induced, is carefully treated. In several different genera, the apogamous sporophytes are shown to arise from diploid gametophytes, which in turn are produced by diploid spores. Such spores result from regular meiosis in tetraploid spore mother cells, which in turn are produced by a process of chromosome doubling by means of abnormal mitoses in the archesporial cells. When this premeiotic doubling does not take place, meiosis in the apogamous species is very irregular, and indicates their hybrid origin.

Among the general conclusions is the one (p. 263) "... that polyploidy as such is not in itself either ancient or modern or an adaptation to cold or any other single climatic or ecological factor, but ... is correlated with climatic or geographical upheavals however caused." This conclusion resulted from a comparison between chromosome numbers of the ferns of Great Britain, where most of the polyploids appear to be of Pleistocene origin, with the numbers found on the island of Madeira, where the polyploids are apparently much more ancient, though just as numerous. A second conclusion is that hybridization between species has been very frequent, many hybrids having been recognized in the European flora. A very different cytological phenomenon, alteration in chromosome shape, is important in some groups, particularly in *Lycopodium* and its relatives, in which the chromosomes at meiotic metaphase are in a remarkable despiralized condition. Chromosome size appears to diminish as the numbers increase. This increase in chromosome numbers must be due to the high survival value of the higher numbers, which is only partly explained. The ability of allopolyploid species to survive in new habitats, while their parents become extinct with the disappearance of old habitats, is suggested as an important cause.

Dr. Manton has reached certain conclusions about evolution in general. The first of these is (p. 290). "... evolution, as such, is a phenomenon for which no cause need be assigned other than the fundamental instability of living matter." Her second is that the numerous examples of parallel evolution within the Pteridophyta will be eventually explained through an understanding of the molecular and atomic structure of their chromosomes. Although she denies belief in

orthogenesis as some "inseparable mystic force," she nevertheless believes in internally directed evolutionary trends of some sort. In the opinion of the present reviewer, all the examples of parallelism that she mentions can be explained on the assumption that similarly constructed, though distantly related, organisms will react similarly to the same or parallel changes in the environment.

To the specialist on the Pteridophyta, Dr. Manton's book will have a value approaching those of Bower and the other great authorities of the past. To the student of plant evolution in general, it will serve as both a stimulus and a challenge to produce similar studies of such high excellence in other groups of plants.

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The Perception of the Visual World. James J. Gibson; Leonard Carmichael, Ed. Boston: Houghton Mifflin, 1950. 235 pp. \$4.00.

This book presents an interesting discussion of visual perception, written as only a psychologist thoroughly familiar with the language of the Gestalt school could write. It is an exposition of ideas worked out during a war research project on the visual perceptual problems of the aircraft pilot.

The essential theme is "that visual space-perception is reducible to the perception of visual surfaces, and that distance, depth, and orientation, together with the constancy of objects may all be derived from the properties of an array of surfaces." In line with the concepts of the Gestalt psychologists, who have insisted that the perception of form is a fundamental sense response, and is not merely an intellectualized summation of individual parts of the form, Dr. Gibson makes the hypothesis that the spatial and temporal changes in the retinal image patterns of textured surfaces constitute the fundamental sense response for the perception of depth and distance. The change in the angular size of the details of the texture of surfaces, such as that of the ground as it recedes into the distance, he calls a "gradient." The perception of the slant and apparent distance of the surfaces are immediately and directly perceived through these retinal image gradients.

The greater part of the book is concerned directly with the concepts of gradient, the relationship of the gradient to the retinal image as the stimulus. Not only does this include the concept of texture gradient, but also the convergence of parallel lines in perspective which is a gradient. The relative intensity of shadow or illumination on solid objects constitutes a gradient. Binocular vision and stereopsis are a response to abrupt changes in gradients. Aerial perspective is an aspect of gradient. Of considerable interest, also, is the author's discussion of change of deformations in retinal image gradient with motion; that is, motion of objects and of the observer. Even the rate of

changes of motion, a rate of change in gradient, results in a psychologic correlative of acceleration.

Of special interest is Gibson's hypothesis that the so-called size constancy phenomenon (wherein objects are perceived in their true size regardless of their distances) is accounted for in terms of the gradient of textured surfaces. Associated with the perception of gradient is a psychologic size scale carried by each person which provides the basis for perception of the size of objects, the objects always being associated with the gradient of the background surface.

The last chapters cover the controversial subjects of learning, the effect of learning upon perception, and the essence of meaning in perception of form and depth.

It would certainly appear that gradients in retinal image patterns could not of themselves provide a reliable guide to absolute spatial localization. Knowledge of the nature of the detail that makes up the texture of surfaces, as well as postural influences of the individual, must be determining factors. The change in angular size of detail varies inversely as the square of the slant distance from eye to surface, and the gradient has symmetry around the foot of the perpendicular line from eye to surface. Hence, even a vertical surface can exhibit the same gradient of details as can a horizontal one for the same perpendicular distance.

This book provides much food for thought on the general problem of perception, although at times it leaves the critical reader somewhat unsatisfied, as perhaps it should. Much research, as Dr. Gibson points out, will be necessary to validate these hypotheses. The book is recommended for those particularly interested in the visual sense, but even the casual reader will find it readable and instructive.

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Plant Biochemistry. James Bonner. New York: Academic Press, 1950. 537 pp. \$6.80.

The subject matter of plant chemistry would seem to be of primary importance to biology as well as to agriculture and substantial segments of industry. It is curious, therefore, that texts dealing with the chemical composition and metabolic activities of plant life have appeared only infrequently over the years; and these have not been notable for their grasp of subject matter or problems. Publication of this text by Bonner has, for the first time, presented the student and the researcher with an integrated source of relatively up-to-date information. Whatever may be found wanting among its pages, this pioneering treatment is bound to prove of substantial use to those interested in plant science and technology.

The author chose one of several possible outlines of subject matter. Indeed, the difficulty inherent in choosing any single organizational pattern is well expressed in his first chapter, "... the subject matter of this book is cyclical rather than linear in arrange-

ment. . . . It is merely an unfortunate geometric necessity which confines the textbook of biochemistry to a linear sequence in its presentation."

Chapter 1 treats in an extremely brief and general way of the biology and chemistry of enzymes. This is strategically the most important chapter of the entire book and yet is given the weakest treatment. Although the struggle to find room for the descriptive matter pertaining to plant biochemistry must have been great, it is equally true that almost no textbook of biochemistry, be it plant or animal, deals adequately with the principles of chemical reaction mechanism, catalysis, and modern rate theory. It will be the task of the biochemist to supply this groundwork. Until biochemistry has begun to evolve into a quantitative science, the teacher of this subject will not be able to depend upon physical and organic chemistry to supply those qualitative concepts that underlie modern theories of chemical reactivity in biological systems.

Chapters 2 through 6 contain a great deal of material on the test tube chemistry of carbohydrates that might well have been omitted in favor of the inclusion of more plant material later on. These chapters might also have been improved by the use of the Haworth formula throughout. The discussion on interconversions of the sugars in chapter 4 is well handled. Chapters 7 to 13 describe the components of the cell wall and their organization, to give perhaps the most satisfactory section of the entire volume. The author is at home with his subject matter and gives an excellent résumé of a subject that is adequately treated elsewhere only in Frey-Wyssling's monograph.

The chapters on the organic acids and plant respiration contain many excellent features, but the general treatment of this difficult field fails to achieve the degree of integration one might desire. On the other hand, the section on nitrogen metabolism is relatively complete. Particularly welcome is the chapter on purines and pyrimidines. Nitrogen metabolism of seedlings, a particularly significant aspect of plant chemistry, might have been treated more fully now that Chibnall's book is out-of-print. Chapters on proteins and viruses include much of the work of the author's own laboratory, a part of which has recently been confirmed, in effect, by Pirie. Recent work on the proteases of green leaves and on the possible mechanisms of peptide bond synthesis is either omitted or barely mentioned. Indeed, the entire problem of protein structure and synthesis is subordinated to the various aspects of protein degradation—no doubt as a consequence of the preponderance of data on protein catabolism in the literature.

The chapter on lipids and lipid metabolism is well done. This segment of plant chemistry has received embarrassing neglect at the hands of physiologists and biochemists. Aside from their significance in cell metabolism, the technological importance of the plant fats and waxes is such that thorough investigation of

their biosynthesis and the quantitative aspects of their production would seem to have been a primary objective of at least some research laboratories. Yet this has not been the case, and every recurring national emergency finds us wondering why something isn't done about the oil and fat situation. Nature has given us the genes, and science the tools, but imagination in their use is lacking.

Somewhere in the book a brief treatment of the plant sterols and steroidal glycosides might well have been included, not only for the sake of their still-un-discovered biochemical activities in plant tissues, but also for their growing importance as raw materials for the synthesis of steroid hormones.

The last section deals with certain aspects of plant growth, and includes chapters on the growth hormones and the new work on photosynthesis. These topics are ably treated—the only change that one might have wished would be the inclusion of additional material on the hormonal aspects of development and the metabolic relationships of the hormones and synthetic growth regulators.

In a general sense, the point of view of *Plant Biochemistry* would seem to parallel that of classical animal and medical biochemistry. Thus, there has been a tendency to consider the properties of substances and systems more or less detached from their operational frames of reference—e.g., ontogenetic and phylogenetic development, ecological adaptation, etc. Inferences have been made, and necessarily so, concerning the nature of biochemical pathways by drawing not only upon incomplete evidence from the botanical literature but also upon analogy from animal and microbial biochemistry. Some may cavil at this speculative approach, but the fact remains that a work of this nature would scarcely have been possible otherwise.

In his preface the author thanks "students in his successive classes for aid in collection of much of the original material." This technique of book writing may perhaps explain the passing resemblance of some sections to chapters in recent volumes of certain review journals. Again, however, the very enormity of the task of sifting and assembling material for such a text from the original literature of organic chemistry and plant physiology would seem to justify such a practice. The alternative might well have been a delay of years in preparation of the manuscript.

The few typographical errors, such as the misuse of "quantum" as the molar equivalent of light energy, are obviously slips of the pen. The printing is excellent, and the composition and binding are attractive. The book is unique in being the only one in its field and should be on the desk of every botanist, chemist, biochemist, and industrial research director.

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News and Notes

Scientists in the News

C. Walton Lillehei has been named winner of the Theobald Smith Award in Medical Sciences for 1951. A graduate of the University of Minnesota Medical School, Dr. Lillehei is now clinical instructor in the Department of Surgery at that institution. The award, consisting of \$1,000 and a bronze medal, was established by Eli Lilly and Company in 1936 and is given for "demonstrated research in the field of the medical sciences, taking into consideration independence of thought and originality." The presentation was made at the Circulation Dinner of the Cleveland meeting of the Federation of American Societies for Experimental Biology by Malcolm H. Soule, vice president of the AAAS and chairman of the Section on Medicine. Dr. Soule was also chairman of the awards committee, of which Otto Kraymer and Kirtley F. Mather, of Harvard; William S. McCann, of the University of Rochester School of Medicine and Dentistry; and Harlan G. Wood, of Western Reserve School of Medicine, were the other members. Much of Dr. Lillehei's research has been concerned with endocarditis, glomerulonephritis, and related ailments.

Eleven scientists have been named by President Truman to a Science Advisory Committee of the Office of Defense Mobilization, to advise the President and Mobilization Director Charles E. Wilson in matters relating to scientific research for defense. **Oliver E. Buckley**, chairman of the board of Bell Telephone Laboratories, will be chairman of the group, the other members of which are **Detlev W. Bronk**, president of Johns Hopkins University and of the National Academy of Sciences; **William Webster**, chairman of the Research and Development Board; **Alan Waterman**, director of the National Science Foundation; **Hugh Dryden**, of the Interdepartmental Committee on Scientific Research and Development; **James B. Conant**, president of Harvard; **Lee DuBridge**, president of Caltech; **James R. Killian**, president of MIT; **Robert F. Loeb**, of the College of Physicians and Surgeons of Columbia University; **J. Robert Oppenheimer**, director and professor of physics at the Institute for Advanced Study, Princeton; and **Charles A. Thomas**, executive vice president of the Monsanto Chemical Company.

Hugh H. Bennett will continue as chief of the Soil Conservation Service beyond the normal date for retirement. He has been with the U. S. Department of Agriculture since 1903, as soil chemist and soil surveyor, and as chief of the Soil Conservation Service since its establishment in 1935. Dr. Bennett, now 70 years old, has had nearly 48 years of service in the department.

Lyle B. Borst, chairman of the Department of Reactor Science at Brookhaven National Laboratory, was elected chairman of the Federation of American

Scientists for 1951-52. **W. A. Higinbotham**, present FAS chairman and head of the electronics division at Brookhaven Laboratory, was chosen vice chairman. **Alan H. Shapley** is retiring June 1 from chairmanship of the FAS Executive Secretariat.

Robert C. Botsford, chief, Division of Mosquito Control of the State Department of Health, has retired after 28 years of service to the state of Connecticut. Mr. Botsford entered the Connecticut Agricultural Experiment Station in 1923 as deputy in charge of mosquito control. When the State Board of Mosquito Control was established by the General Assembly in 1939, he was named superintendent, and has been chief of the Division of Mosquito Control since the beginning of the present year.

E. J. Crane, of Columbus, Ohio, for the past 37 years editor of *Chemical Abstracts*, has been awarded the Priestley Medal for 1951. Dr. Crane, who was cited for "distinguished services to chemistry," will receive the medal at the society's Diamond Jubilee meeting in New York next September. He is currently engaged in the compilation of a 27-year collective formula index to *Chemical Abstracts*, which will cover the years 1920-46.

Herrell F. DeGraff will become the first Babcock Memorial Professor at Cornell. The chair honors the late H. Edward Babcock of Ithaca, a long-time member of the Cornell Board of Trustees, who devoted much of a life of agricultural innovation to the improvement of diet in America. Established in the School of Nutrition, the professorship and associated research will be supported from a \$500,000 fund being raised by friends and business associates of the agricultural leader. Dr. DeGraff, as Babcock Professor of Food Economics, is an authority on agricultural production and distribution. He has been a member of the faculty of the College of Agriculture at Cornell since 1940.

J. J. Demuth, president of the American Society of Tool Engineers, and general superintendent, Sligo, Inc., St. Louis, has been awarded an honorary membership in the Institute of Production Engineers, the British equivalent of the ASTE.

Charles Stark Draper has been appointed head of the Department of Aeronautical Engineering at MIT, succeeding **Jerome C. Hunsaker**, who founded the first professional course in aeronautical engineering in 1914. Dr. Hunsaker, who asked to be relieved of administrative responsibility for the department, will continue as a professor until his retirement next year. Dr. Draper, professor of aeronautical engineering, has been deputy head of the department as well as director of the Instrumentation Laboratory, which he will continue to administer.

Thomas E. Eakin, of the Carson City, Nev., office of the Ground Water Branch, Water Resources Divi-

sion, USGS, has been assigned to the Technical Reports Section of the Ground Water Branch in Washington.

George Gamow, professor of theoretical physics at George Washington University, will discuss "The Origin and Evolution of the Universe" as a Sigma Xi national lecturer. Fourteen Sigma Xi chapters and clubs are included in his lecture itinerary.

The Department of Biological Sciences at Purdue has received a grant of \$18,000 from the American Cancer Society for a Scholar in Cancer Research. **Harold R. Garner** has been appointed under this grant and will have as his general field of investigation the genetic control of biochemical reactions in microorganisms, with emphasis on mutagenesis by photodynamically active carcinogens.

William F. Guyton and **Walter N. White** have opened offices as consulting ground-water hydrologists in Austin, Texas, with a branch office in Silver Spring, Md. Both men were formerly with the Ground Water Branch, Water Resources Division, U. S. Geological Survey.

Austin F. Henschel has resigned his post at the Laboratory of Physiological Hygiene, School of Public Health, University of Minnesota, to become scientific director of the Quartermaster Climatic Research Laboratory at Lawrence, Mass.

Koji Hidaka, of Tokyo University, has been named a Walker-Ames professor in physical oceanography at the Oceanographic Laboratory at Friday Harbor, Wash., for the summer of 1951. **C. Ladd Prosser**, of the University of Illinois, will give courses in advanced invertebrate zoology, and **G. Clifford Carl**, director of the Provincial Museum at Victoria, B. C., will give the course in problems in fisheries biology at the laboratories this summer.

V. N. Ipatieff, of Universal Oil Products Company, was elected an honorary member of the Société Chimique de France at a recent meeting of the General Assembly of the society, in tribute to his outstanding scientific reputation and in recognition of his helpfulness to French scientists. Dr. Ipatieff is director of the Ipatieff High Pressure and Catalytic Laboratory in the Technological Institute of Northwestern University.

Clive R. Johnson has been named director of the new Fort Worth Laboratory for Surgical and Medical Research of the Fort Worth Branch of Southwestern Medical School of the University of Texas. Dr. Johnson is a former fellow in surgery in the Mayo Foundation.

James B. Kring, formerly of Kansas State College, has joined the staff of the Entomology Department of the Connecticut Agricultural Experiment Station, where he will specialize in work on soil insects, and

particularly on control of wireworms on tobacco and potatoes.

C. C. Lawrence, of the British Embassy; **R. L. Wain**, of Wye College, England; **Roberto Quinones**, Minister of Agriculture in El Salvador; **Teresa Ortiz de Torres**, of the Trudeau Hospital in Santiago, Chile; **A. J. Anderson**, senior research officer in Australia's Ministry of Agriculture; and **John Hancock**, chief animal geneticist in New Zealand's Luakura Livestock Research Station, were among recent foreign visitors at the Washington and Beltsville bureaus of the Agricultural Research Administration.

A. A. Lindsey, professor of botany, Purdue University, has been granted a leave of absence for the summer of 1951 and will serve as ecologist with the U. S. Engineers Joint Highway Research Project in Alberta, British Columbia, Yukon, and the Northwest Territories.

An annual lectureship to honor the first two men to head departments of chemistry and chemical engineering at Illinois Institute of Technology has been established by Omicron chapter of Phi Lambda Upsilon. The McCormack-Freud Honorary Lecture has been named for Professors Emeritus **Harry McCormack** and **Benjamin B. Freud**, who discussed "Development of Chemistry and Chemical Engineering at Illinois Institute of Technology" at the first lecture in the series, on April 25.

The **Hugh W. Mahon** Lectureship, the first to honor a member of the regular Army Medical Corps, has been established, and the first lecture was given by Colonel Mahon at Fitzsimons Army Hospital, on "Coccidioidomycosis." These endowed lectures will be given annually at Fitzsimons by distinguished medical leaders. Colonel Mahon was stationed at the hospital for twelve years as chief of the laboratory service.

Georg Maria Schwab has accepted the chair of physical chemistry at the University of Munich. He has been director of the Physico-Chemical Institute at Piraeus, Greece, during the past fifteen years and only recently returned to Munich.

The sixty-fifth birthday of **Paul Schwarzkopf**, on April 13, was celebrated by a special issue of the *Powder Metallurgy Bulletin*, containing papers of co-workers who are recognized as authorities in the field of powder metallurgy. Prominent among the achievements of Dr. Schwarzkopf and his co-workers is the development of the multicarbide tools, the porous nickel cup for the proximity fuse, new heat-resistant metal compounds, and the sintered and infiltrated compressor blade for jet engines. Dr. Schwarzkopf is the founder of the Metallwerk Plansee, in Reutte, Tyrol, and of the American Electro Metal Corporation, Yonkers, N. Y.

The American Institute of Nutrition will make the following awards at its meeting in Cleveland on May

1: Osborne and Mendel Award, to **Esmond E. Snell**, professor of biochemistry at the University of Wisconsin, for his studies on the nutritive requirements of microorganisms and the development of assay methods for vitamins and amino acids; **Borden Award in Nutrition**, to **Paul György**, professor of nutrition, department of pediatrics at the University of Pennsylvania School of Medicine, for his contributions on riboflavin, pyridoxine, biotin, and other nutrients found in milk and dairy products.

Richard V. Southwell, rector of the Imperial College of Science and Technology in London, recently gave a course in relaxation methods in engineering at the U. S. Naval Ordnance Test Station, Inyokern, China Lake, Calif. The course was offered through the Off-Campus Graduate Program of the University of California, Los Angeles, where he is teaching this semester. **Polidore Swings**, Belgian astrophysicist, and **Raymund Sanger**, of Switzerland, were recent guest lecturers at Inyokern. Dr. Swings, who came from the University of Liège, is now a visiting professor of astrophysics at Caltech. Professor Sanger, who has been a research associate in applied mathematics at Caltech for the past year, plans to rejoin the faculty at the Swiss Federal Institute of Technology at Zurich soon. **Leonard J. Jagiello** has left the U. S. Naval Ordnance Test Station to become chief aerodynamicist with the Raytheon Manufacturing Company at Waltham, Mass.

Walter B. Spangler and **Jahn J. Peterson**, Esso Standard Oil Company geologists currently assigned to the Creole Petroleum Corporation, Caripito, Venezuela, were joint winners of the American Association of Petroleum Geologists President's Award for 1951. This award is made annually to the author, or authors, under 35 years of age, of the "most significant original contribution to petroleum geology" published in the monthly *Bulletin* of the association during the previous year. The winning paper, entitled "Geology of Atlantic Coastal Plain in New Jersey, Delaware, Maryland, and Virginia," was published in the January issue of the *AAPG Bulletin*.

O. E. Stanaitis, of the University of Vilna, has been appointed to an instructorship at St. Olaf College.

George M. Sutton, associate professor of zoology and curator of birds, Museum of Zoology, University of Michigan, will be a staff member at the University of Oklahoma Biological Station, Lake Texoma, during the summer of 1951. Dr. Sutton will teach ornithology and instruct and advise graduate students both in ornithological research and bird illustration. The 1951 summer session runs from June 9 through August 4.

Estella Ford Warner, as regional public health representative in the Near East, will participate in a new project under which Point Four grants and technical services will be used to help establish a school of public health at the American University in Beirut. Dr. Warner has been chief of the Division of State Grants of USPHS since its organization in 1949.

Colleges and Universities

Boston College will hold a special two-week intensive course in Modern Industrial Spectrography at Chestnut Hill, July 23-August 3. The course has been designed particularly for industrial chemists and physicists whose firms are in the process of installing spectrographic equipment. For information write to James J. Devlin, Boston College, Chestnut Hill, Boston 67.

The **University of California** will hold a Workshop for Science Teachers on its Berkeley campus June 25-July 13. Philip G. Johnson, of the U. S. Office of Education, will be in charge of the program, which will include study of proper school facilities for science instruction, and adaptation of instruction to take account of individual differences. The NSTA summer conference in Oakland, June 28-30, has been planned as part of the workshop. Further information may be obtained from the Department of Conferences and Special Activities, University Extension, University of California, Berkeley 4.

The **Catholic University of Saint Mary**, founded three years ago in Ponce, P. R., recently dedicated its new Antonio Ferré School of Sciences, a \$250,000 building constructed with funds donated by the Ferré family of Ponce. The university has an enrollment of more than 1,000.

A Summer Seminar in Statistics will be held at the **University of Connecticut**, at Storrs (August 6-31). The principal seminar will offer Applications to Biology (C. I. Bliss and J. Ipsen); Time Series (M. G. Kendall, J. W. Tukey); Statistical Theory; Probability (M. Kac, H. Robbins); Techniques of Interest in Social Science (F. Mosteller, F. L. Strodbeck, M. A. Woodbury). For further information write to D. F. Votaw, Jr., Leet Oliver Memorial Hall, Yale University, New Haven.

The **University of Miami** and the **University of Puerto Rico** are joint sponsors of a special graduate summer course in the Biology of Fishes, to be taught at Mayaguez, P. R., July 2-August 15. Luis René Rivas, of the University of Miami, will instruct. Address applications to Director of the Summer Sessions, University of Miami.

A Seminar in Applied Linguistics, sponsored by the American Council of Learned Societies, will be held at the **University of Michigan** June 25-August 17. In addition to Michigan faculty members, Charles Bruneau, of the Sorbonne, will be on the staff, as will R. Jackson (Harvard), M. Joose (Wisconsin), W. G. Moulton and W. E. Womers (Cornell), R. L. Ward (Yale), and H. Wolff (Puerto Rico).

Advanced courses in mathematics for 1951 will be given by: Teachers College, Columbia University (July 2-August 10); De Paul University (June 25-July 31); Oklahoma Agricultural and Mechanical College (June 18-July 14); University of California,

Berkeley (June 18-July 28); and University of Tennessee (June 11-August 24).

James H. Zumberge will be in charge of a **University of Michigan** geology field course in which the following points are scheduled to be visited: Copper Harbor, Isle Royale, Keweenaw Point, Houghton, Calumet, Ironwood, Escanaba, Manistique, Sault Ste. Marie, Tahquamenon Falls, Mackinac Island, Les Cheneaux Islands, Rogers City, Sleeping Bear Dunes, and Traverse City. Information may be obtained from Dr. Zumberge, Department of Geology.

A course in Marine Invertebrate Zoology at the **University of New Hampshire** (July 2-August 10) will include a survey of the major invertebrate groups, with emphasis on the inshore marine fauna. About one fourth the laboratory time will be devoted to field work on the ocean, the Isles of Shoals, and in the estuarine waters of Great Bay, making it possible to collect and to study marine invertebrates in their natural habitats. For further information address George M. Moore, Department of Zoology.

Oak Ridge Institute of Nuclear Studies has scheduled three basic four-week courses in radioisotope techniques to begin on June 11, July 9, and August 15. An autoradiography course, the first of its kind to be offered at Oak Ridge, will start July 2. It is intended for personnel who will direct medical or biological research in this field. For additional information and application forms, write to Ralph T. Overman, P. O. Box 117, Oak Ridge, Tenn.

A Teachers Seminar on Pharmacology and Related Subjects will be held at **Purdue University School of Pharmacy**, July 9-14. It is open to teachers of pharmacology, graduate students, laboratory pharmacologists, administrators of schools of pharmacy, and others. The seminar is made possible through the American Association of Colleges of Pharmacy. Glenn L. Jenkins, Purdue, chairman of the seminar, will supply further information.

Simmons College will hold a summer institute of its School of Library Science June 18-22, with particular emphasis on the librarian's responsibility for aiding people to think about and discuss problems of significance in today's living. Sigrid Edge, Simmons College, 300 The Fenway, Boston 15, will supply registration blanks and further information.

Washington College, Chestertown, Md., is expanding its physics curriculum to meet new demands for technically trained personnel. Courses will be offered this summer in fluid dynamics and mechanical vibrations. Next year the university will introduce a two-year sequence in mathematical and theoretical physics.

Washington University School of Medicine, aided by ECA funds, will begin a cooperative teaching program with the Siriraj Medical and Nursing School and the Chulalongkorn Hospital Medical and Nursing School, in Bangkok. The program will include an

exchange of nurses, medical technicians, and nurse anesthetists, as well as physicians, and will be under the direction of Robert A. Moore and Ben Eiseman. The latter has already left for Thailand.

Workshops in special education, social service, psychology, and cerebral palsy will be held under the auspices of the **National Society for Crippled Children and Adults** at the Universities of Utah and Wyoming, Eastern Montana College of Education, New Haven State Teachers College, Michigan State Normal, Syracuse University, Teachers College, Wayne University, Western Michigan College of Education, and Bowling Green State University. Further information may be obtained from the society, whose address is 11 S. La Salle St., Chicago 3.

Dedication exercises for **Ohio State University's** new Medical Center will be held the week of May 14. The program will begin with scientific sessions for the Post-College Assembly of the College of Dentistry; formal dedication ceremonies are scheduled for May 15; and on May 16 the College of Medicine will conduct scientific sessions of its Post-Collegiate Assembly. New buildings to be dedicated are the 600-bed new University Hospital, the College of Dentistry building, the 300-bed Ohio Tuberculosis Hospital, and the 140-bed Columbus Receiving Hospital for mental patients. The Dentistry building is now in use; the other three buildings are nearing completion.

Meetings and Elections

The **National Chemical Laboratory of India**, at Poona, has organized a series of symposia on various chemical topics, to bring together representatives of government, industry, and educational and research institutions. Since October 1950 six symposia have been held, and five additional meetings are planned: May 4, Rubber and Rubber Waste; June 8, Organic Fine Chemicals and Industry; July 6, Chemicals for Agriculture; August 10, Chromatography; September 11-14, Vegetable Oils and their Utilization; and November 9, Utilization of Industrial Waste.

Representatives of most of the laboratories in the U. S. and Canada that are involved in the manufacture of **tetanus and diphtheria toxoids** met on February 26-27 at the Harvard Medical School. The gathering was arranged by J. Howard Mueller, of the Department of Bacteriology and Immunology, for the purpose of pooling available information on toxin production, both experimental and practical, in order to make optimal production procedures as widely available as possible. The following government and industrial groups were represented: Division of Biologics Control of the USPHS; U. S. Army Medical Center; the Connaught Laboratories of Toronto; the Illinois Department of Public Health; the Massachusetts Antitoxin and Vaccine Laboratories; Cutter Laboratories; Eli Lilly & Company; Lederle Laboratories; National Dairy Research Laboratories; National Drug Company; Pittman-Moore Company; Sharp & Dohme; Sheffield Farms Company; E. R. Squibb &

Company; Wyeth Incorporated; and the U. S. Standard Products Company.

Approximately 500 physicians, surgeons, and specialists from all parts of the U. S. and Canada attended the first symposium of the recently established Research Council of United Cerebral Palsy at the New York Academy of Medicine on April 14. Among the participants were Sidney Farber, Wilder Penfield, H. Houston Merritt, Seymour Kety, Klaus R. Unna, Bronson Crothers, Russell Meyers, H. W. Magoun, and Abner Wolf.

Reorganization of the advisory board for *The Science Teacher* provided for six members elected for three-year overlapping terms. Members are: Marjorie H. Campbell (1951), Washington, D. C., public schools; Charlotte L. Grant (1951), Oak Park High School, Oak Park, Ill.; Morris Meister (1953), Bronx High School of Science, New York; Elbert C. Weaver (1952), Phillips Academy, Andover, Mass.; Hanor A. Webb (1953), George Peabody College for Teachers, Nashville, Tenn.; and Harold Wise (1952), University of Nebraska, Lincoln. Dr. Meister has been named chairman of the board for the year 1951.

At the second meeting of the International Committee of Electrochemical Thermodynamics and Kinetics at Milan, Pallanza, and Varenna, Italy, the following officers were elected: P. Van Rysselberghe, president; T. P. Hoar and R. Piontelli, vice presidents; M. Pourbaix, secretary-treasurer. The third meeting will be held at the University of Bern during the week of August 6. Marcel Pourbaix, Laboratory of Applied Physical Chemistry, University of Brussels, 50 Ave. F. D. Roosevelt, Brussels, Belgium, will answer questions concerning the meeting, and K. Huber, Chemical Institute, University of Bern, concerning hotels and other arrangements.

A Symposium on Coral Atoll Research, under the auspices of the Pacific Science Board of the National Research Council, was held last February in Honolulu. Among those discussing the many phases of such work were H. G. MacMillan, F. R. Fosberg, Doak Cox, R. W. Hiatt, Vernon Brock, O. E. Sette, C. E. Pemberton, Leonard Mason, Katharine Luomala, K. P. Emory, Philip Drucker, and E. H. Bryan, Jr. A committee consisting of the chairman, Harold J. Coolidge, and the discussion leaders, approved a program of team research on atolls, each team to include a marine geologist, a plant ecologist, a marine ecologist, and an anthropologist.

The British Gelatine and Glue Research Association, at its annual general meeting in Aldwych on February 7, reelected G. W. Odey president. At its third Research Panel, held the next day in London, papers were presented on the use of gelatin and animal glue in industry; special problems connected with the use of gelatin in foodstuffs; some aspects of the use of gelatin in the photographic industry; and paper sizing.

The Eastern Psychological Association, at its annual meeting March 30-31 at Brooklyn College, elected Frank A. Beach, Yale, president, succeeding Carl I.

Hovland; James J. Gibson, Cornell; Clifford T. Morgan, Johns Hopkins; and E. B. Newman, Harvard, to the Board of Directors. The association voted to hold its next meeting in Atlantic City and the 1953 meeting in Boston.

At the Bangalore meeting of the Council of the National Institute of Sciences of India, 15 Indian scientists were elected to Ordinary Fellowship. Honorary Fellowship was awarded to Alexander Fleming, of St. Mary's Hospital, London; Richard Kuhn, of the Kaiser Wilhelm Institute, Heidelberg; Hermann J. Muller, of Indiana University; and Selman A. Waksman, of the New Jersey Agricultural Experiment Station.

The Ohio Academy of Science held its sixtieth annual meeting at Miami University April 5-7. W. H. Shideler was elected president; Rush Elliott, secretary; and R. M. Geist, treasurer. The 1952 meeting will be held at Kent State University April 17-19; the 1953 meeting at Ohio Wesleyan; and the 1954 meeting at Ohio State.

Sigma Pi Sigma, national physics honor society, recently installed its 77th chapter, at Hofstra College. Installation officers were M. H. Trytten, Donald E. Kirkpatrick, and J. H. Rohrbaugh. Dr. Trytten spoke on "The Role of Higher Education in National Defense."

At the annual conference of the Society of Women Engineers in New York, a new annual engineering award for women was announced. It will be conferred on a woman in the field of engineering design, research, education, or administration. Participating in panel discussions and other sessions of the conference were Mary F. Blade, Hilda Edgecomb, John R. Ragazzini, H. J. Masson, Marion O'Sullivan, Cornelia Snell, and Mary Louise Pottle.

Miscellaneous

The Council on Student Travel announces the availability of two special student boats between Montreal and Le Havre, at a round-trip fare of \$230. The boats are American-built and under Norwegian charter, with accommodations for 1,300. Eastbound sailings are in June and early July, with return in late August and early September. Those interested in traveling on these boats should write immediately to Robert Tesdell, director of the council, 53 Broadway, New York.

The Ford Foundation has established The Fund for the Advancement of Education, a nonprofit organization incorporated in New York. President is Clarence H. Faust, formerly of Stanford, and the directors are Frank W. Abrams, chairman; Barry Bingham; Ralph J. Bunche; Charles D. Dickey; James H. Douglas, Jr.; Dr. Faust; C. Scott Fletcher; Mildred McAfee Horton; Roy E. Larsen; Walter Lippmann; Paul Mellon; Walter P. Paepeke; Philip D. Reed; Owen J. Roberts; and James W. Young. With an interim budget of \$7,154,000, the fund will devote its

attention to educational problems at primary, secondary, college, and university levels, and will authorize basic studies on the contemporary goals of educational procedures. Fund offices are at 916 E. Green St., Pasadena, Calif., and in New York City.

The National Science Foundation has moved to new offices at 901 Sixteenth St., N.W., Washington, D. C.

The W. M. Kellogg Company, which is engaged in development work on rockets and rocket fuels in its Special Projects Department, has appointed Andrew Kalitinsky manager of this department. Mr. Kalitinsky, former chief engineer of NEPA, was educated at the Swiss Federal Institute, Zurich, and since coming to the U. S. has been with MIT, Pratt & Whitney Aircraft, and the Navy Bureau of Aeronautics.

Edmund Salvage Co., Barrington, N. J., has changed its corporate name to Edmund Scientific Corporation. The firm is engaged in the manufacture of optical instruments.

Recent Deaths

David C. Ball (93), chemical industrialist, Lake Placid, N. Y., Mar. 23; William E. Beakes (70), radio pioneer, Miami, Mar. 30; William W. Beckman (40), physician, New York, Apr. 12; Merrill Bernard (58), climatologist and hydrologist, Washington, D. C., Apr. 13; A. Leal Bibbins (59), farm seed expert, Buffalo, N. Y., Mar. 31; Francis R. Bichowsky (53), research chemist, San Francisco, Apr. 5; Vilhelm Bjerknes (89), meteorologist, Oslo, Apr. 9; Robert Broom (84), anthropologist, Johannesburg, Apr. 6; Kathleen L. Buck, physician, Rochester, N. Y., Mar. 21; Harold F. Bullard (62), chemist and paper manufacturer, Boston, Apr. 16; Edwin S. Carman (75), machinery engineer, Cleveland, Mar. 20; Frank A. Chambers (66), smoke abatement expert, Chicago, Mar. 21; Arthur W. Chapman (70), pediatrician, Glens Falls, N. Y., Apr. 10; John Cox, Jr. (90), genealogist, Long Island, N. Y., Apr. 9.

Edward L. Davies (66), mechanical engineer, Garden City, N. Y., Apr. 16; George E. Davis (85), otorhinolaryngologist, New York, Mar. 24; Edmund Ezra Day (67), former president, Cornell University, Ithaca, N. Y., Mar. 23; Charles T. Dolezal (51), hospital administrator, Chicago, Mar. 19; Linn Emerson (77), oculist, Orange, N. J., Apr. 17.

John T. Faig (76), engineer, Cincinnati, Apr. 8; William B. Featherstone (51), educator, New York, Apr. 12; Joseph C. Ferguson (42), radio design engineer, Fort Wayne, Ind., Mar. 27; Edward D. Ferris (86), surgeon, New York, Apr. 5; Julius Floto (85), structural engineer, Manchester, N. H., Mar. 30; Frank A. Giffin (74), statistical analyst, New York, Mar. 26; Frank E. Gissler (47), radar expert, Denville, N. J., Mar. 22; Abraham L. Goldwater (79), physician, New York, Mar. 23.

Rosetta S. Hall (85), medical missionary, Ocean Grove, N. J., Apr. 5; James L. Hanley, dentist, Orange, N. J., Apr. 16; Fred W. Herman (58), aviation engineer, Long Beach, Calif., Mar. 26; Robert D. Hope

(67), consulting engineer, Fanwood, N. J., Mar. 23; Robert W. Hunt (46), urologist, New York, Mar. 31; William F. Hunt, (79), engineer, Waterbury, Conn., Apr. 13; Gomer P. Jones (84), mining engineer, Vancouver, Mar. 29; Theodore T. Knappen (50), hydraulic engineer, New York, Mar. 20; John E. Kotila (58), plant pathologist, Washington, D. C., Mar. 27; William E. Kuckro (73), chemist, Jersey City, N. J., Apr. 14; William P. Kuebler (62), Philadelphia, Mar. 26; Walter E. Lee (71), surgeon, Philadelphia, Apr. 5; Leonid Leibenzon, geophysicist, Moscow, Mar. 17; Frank B. Littell (82), astronomer, Bethesda, Md., Mar. 28; Charles E. Lucke (74), mechanical engineer, New York, Mar. 25.

Roy D. McClure (69), surgeon, Detroit, Mar. 31; John T. Macdonald (66), airline medical director, Miami, Apr. 3; E. Frederick Marsiglio (59), chemist, Cranford, N. J., Mar. 22; William G. Mather (93), industrialist, Cleveland, Apr. 5; Max B. Miller (64), petroleum engineer, New York, Mar. 31; Charles R. Moore (69), engineer, Washington, D. C., Mar. 17; Jared S. Moore (71), philosopher, Boston, Apr. 10; Walter I. Nevius (60), engineer, Frederick, Md., Mar. 25; J. S. Paraskevopoulos (61), astronomer, Bloemfontein, South Africa, Mar. 15; Paul S. Pearce (76), educator, Orlando, Fla., Mar. 30; Elizabeth L. Pickett (83), physician, Aldan, Pa., Apr. 14; John B. Poore (84), engineer, Summit, N. J., Mar. 20; William Procter (78), soap manufacturer, West Palm Beach, Fla., Apr. 19.

Carl Johann Ratzlaff (55), economist, Arlington, Va., Mar. 22; Edward H. Ravenscroft (79), engineer, Phoenix, Ariz., Mar. 24; Heinrich Ries (79), geologist, Ithaca, N. Y., Apr. 11; Mikhail N. Rimsky-Korsakov, entomologist, Leningrad, Mar. 18; Charles M. Robbins (58), Newark, N. J., physician and surgeon, Apr. 4; William L. Russell (87), psychiatrist, Santa Barbara, Calif., Mar. 31; Porter Sargent (78), educator, Cambridge, Mass., Mar. 27; Harry R. Seiwel (46), oceanographer, St. Agapit, Que., Mar. 7; F. F. Sharpless (85), mining engineer, West Chester, Pa., Apr. 11; William D. Silkworth (77), neuropsychiatrist and a founder of Alcoholics Anonymous, New York, Mar. 22; William Skarstrom, hygiene and physical education professor, Duxbury, Mass., Mar. 24; A. Vincent Smith (51), consulting engineer, New York, Apr. 2; Simon Strauss (83), gynecologist and surgeon, St. Petersburg, Fla., Apr. 7; William D. Sturgis (65), engineer, Carmel, Calif., Apr. 6.

Robert B. Taft (51), radiologist, Charleston, S. C., Apr. 16; Alexander D. Tendler (58), psychologist, New York, Apr. 14; George Thomas (84), educator, Salt Lake City, Apr. 11; Frederick E. Turneure (84), engineer, Madison, Wis., Mar. 31; Frank Vassar (76), biochemist, New York, Mar. 17; James M. Watkins (40), agronomist, Baltimore, Apr. 14; Rodney R. Williams (68), psychiatrist, Dobbs Ferry, N. Y., Apr. 14; Charles P. Winsor (55), biometricist, Baltimore, Apr. 4; Thomas D. Wood (86), health education professor, Taunton, Mass., Mar. 20.

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